Sorensen
A **Raytheon** Company

Instruction Manual for

SRL Series Power Supplies

Includes the following SRL models:

Convection Models	Fan Models
10-25	10-50
20-12	10-100
20-25	20-50
40-6	40-25
40-12	40-50
60-4	60-17
60-8	60-35

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SECTION 1

INTRODUCTION

1.1 PURPOSE

This manual contains operation and maintenance data on the SRL series power supplies. The purpose of the manual is to familiarize the user with unit functions, to introduce the varied configurations to which the unit is convertible, and to provide the necessary maintenance data to assure long operating life.

Six major sections form the content of this manual. Section 1 contains a description of the series, highlights important features, and tabulates complete specifications. Inspection and initial checkout procedures are covered in section 2. Operation procedures are outlined in section 3. Section 4 details the theory of operation, and section 5 provides maintenance, service and repair instructions. Schematics, parts lists, operating curves and waveforms are included in section 6.

1.2 DESCRIPTION

The SRL series consists of seven convection cooled models in the 250W to 500W range, and seven fan cooled models in the 500W to 2 kW range. Both have outputs ranging to 60 Vdc. Differences in models are noted as applicable.

1.2.1 Physical

SRL power supplies are designed for either bench or rack mounted use, and for easy component accessibility. All controls used in normal operation are mounted on the front panel. Power outputs up to 25 Amperes may be taken from the unit front mounted binding posts. The mode selector terminal board is at the rear of the supply. Through manipulation of the terminal board links, the functions of voltage/current mode programming, remote sensing and parallel operation are obtained. Output terminals are also provided at the rear of the unit.

Models 20-12, 40-6 and 60-4 have an input fuseholder, and use a front panel power switch. The other convection cooled models (SRL 10-25, 20-25, 40-12, and 60-8) and all fan cooled models (SRL 10-50, 10-100, 20-50, 40-25, 40-50, 60-17, and 60-35) use a circuit breaker.

1.2.2 Functional

The SRL power supplies provide a precisely regulated dc output, adjustable over a wide range. They operate from any of three available ac inputs, and exhibit rapid response to transients, both load and line. Unit characteristics are outlined in specifications table 1-3 and 1-4.

All semiconductors used in the SRL series are silicon types, and contribute significantly to the unit ambient temperature characteristics. High dissipation transistors are mounted to a cast aluminum alloy heatsink; low dissipation devices are located on a plug in printed circuit board.

Table 1-1 SRL Panel Controls/Indicators (Convection Models)

Control	Function
POWER Switch: (CB 1/S1) S1 (Models 20-12, 40-6, 60-4) CB1 (Models 10-25, 20-25, 40-12, 60-8)	Applies ac line voltage to input of put of power supply.
POWER Light (DS1)	Illuminates when POWER switch is in the ON position. (And internal fuse is not blown).
OVERVOLTAGE SET (S2)	Momentary toggle switch, when depressed causes panel dc VOLTS meter to indicate overvoltage trip level.
OVERVOLTAGE ADJ (R85)	Recessed potentiometer to adjust trip level of overvoltage circuit.
OVERVOLTAGE INDICATOR (DS2)	Illuminates when limit set by OVERVOLTAGE ADJ (R85) has been exceeded by the power supply output voltage.
VOLTAGE Controls (R53A, R53B)	Provide coarse and fine adjustment of output voltage. (Voltage Mode)
DC VOLTS Meter (M1)	Provides direct readout of voltage selected by voltage controls.
DC AMPERES Meter (M2)	Provides direct readout of load current.
CURRENT Controls (R18A, R18B)	Provide coarse and fine adjustment of output current. (Current Mode)

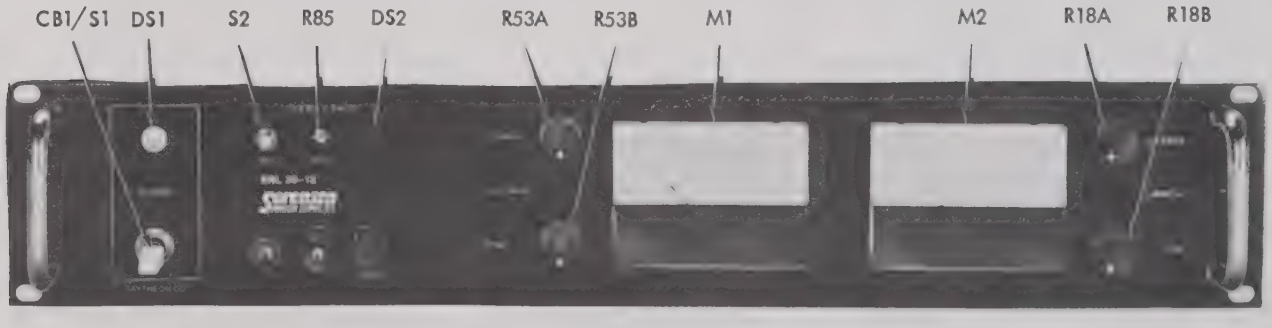


Figure 1-1 Front Panel Controls and Indicators (Typical) (Convection Models)

Table 1-2 SRL Panel Controls/Indicators (Fan Cooled Models)

Control	Function
POWER light (DS1)	Illuminates when POWER switch is in the on position.
OVERVOLTAGE SET (S2)	Momentary toggle switch, when depressed causes panel DC VOLTS meter to indicate overvoltage trip level.
OVERVOLTAGE ADJ (R85)	Recessed potentiometer to adjust trip level of overvoltage circuit.
OVERVOLTAGE INDICATOR (DS2)	Illuminates when limit set by OVERVOLTAGE ADJ (R85) has been exceeded by the power supply output voltage.
DC VOLTS Meter (M1)	Provides direct readout of voltage.
DC AMPERES Meter (M2)	Provides direct readout of load current.
CURRENT Controls (R18A), (R18B)	Provide coarse and fine adjustment of output current. (Current Mode)
VOLTAGE Controls (53A, R53B)	Provide coarse and fine adjustment of output voltage. (Voltage Mode)
THEMAL OVERLOAD (DS3)	Illuminates when unit temperature exceeds a preset limit.
POWER Switch (CB1)	Turns on the power supply.

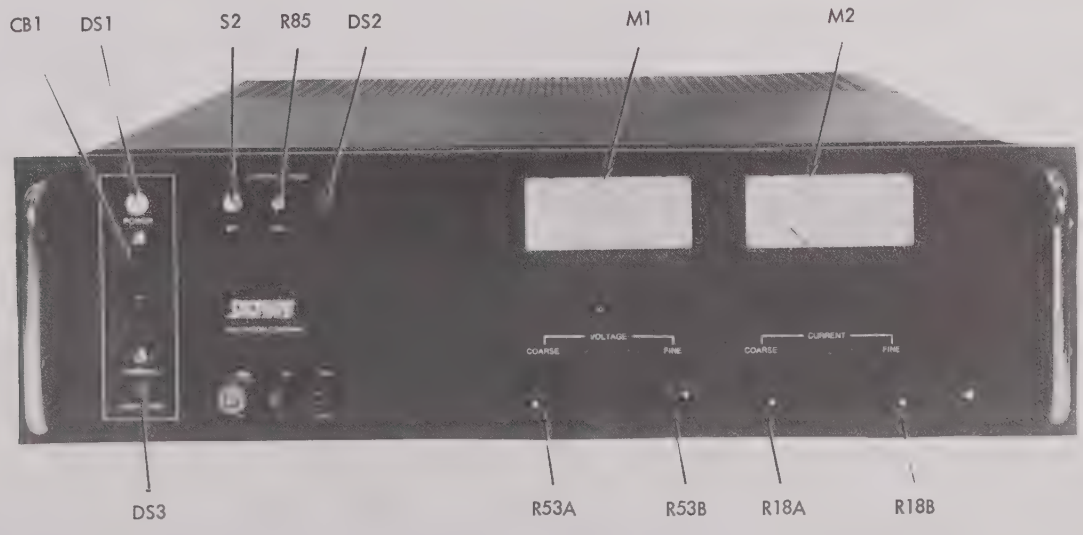


Figure 1-2 Front Panel Controls and Indicators (Typical) (Fan Models)

1.2.2.1 Operating Modes

SRL models have two basic operating modes: constant voltage and constant current. In the former, the output voltage is regulated by the front panel selected or programmed value, and the output current varies with the load. In constant current operation, the output current is regulated at the selected value while the output voltage varies as a function of load.

1.2.2.2. Automatic Crossover

The automatic crossover capability enables the unit to transfer operating modes as a function of load requirements. If, for example, load current attempts to increase above the setting of the current adjust control, the unit will switch operation automatically from the voltage to the current mode. If the load requirements are lowered, return to the voltage mode will occur automatically.

1.2.2.3 Remote Programming

Any SRL model may be remotely programmed, that is, its output may be altered from a distant location in either the voltage or current mode by introducing a calculated resistance or signal into the appropriate programming circuit. This may be readily accomplished through the link arrangements at the rear terminal board.

1.2.2.4 Remote Sensing

Terminals located on the rear terminal board offer the means of extending a unit's regulating point from the output terminals to the load. This, in effect, compensates for variations in the load lead voltage drop. The maximum drop for which a unit will compensate is one volt per load lead.

1.2.2.5 Series Operation

For applications requiring voltages higher than a single SRL can provide, a number of units may be connected in series. Maximum system output is specified at 200 Vdc. Unit connections are illustrated in Section 3. Regulation in series operation is the sum of the regulations for all units. In series operation, external rectifiers to protect units against reverse voltage, developed by a unit malfunction, are unnecessary. Reverse voltage protection is designed into the unit.

1.2.2.6 Parallel Operation

Parallel operation may be used to service those applications requiring a higher output current than a single SRL can provide. Unit connections are illustrated in section 3. Paralleling is indirect through a master/slave approach, i.e., the amplifier of the master unit controls the output of all units in the system. In parallel operation, the maximum output current of each unit is derated to 90%.

1.2.2.7 Protection Features

Protection against the effects of overloads and internal short circuits is provided; in the first case, by automatic crossover, and in the second by the input fuse or

circuit breaker. In addition, open sensing leads or links will not drive the unit into high output voltage. Internal rectifiers preclude this by clamping the output to approximately 1-1/2 volts above output setting.

Internal control circuitry is protected by a fuse connected in the primary of the input transformer.

Fan cooled units are additionally protected by a thermostatic control circuit to automatically shut the unit down in the event of thermal overload.

Table 1-3 Convection Cooled Unit Specifications (Sheet 1 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
INPUT RATINGS	105-125V (Standard) 190-230V (M1)							
Voltage Range	210-250V (M2)							
Frequency	47-53/57-63Hz							
Phase	1							
Current (Adc Max)								
@ 115Vac		7.8	6.3	6.0	7.5	13.6	13.2	12.5
@ 210Vac		4.3	3.5	3.3	4.1	7.5	7.3	6.9
@ 230Vac		3.9	3.2	3.0	3.75	6.8	6.6	6.25
Power Factor (typical)		0.65	0.58	0.66	0.67	0.64	0.56	0.54
Efficiency (typ)		42%	56%	50%	45.5%	52.5%	60%	64%
OUTPUT RATINGS								
Voltage Mode:								
Voltage Range (Vdc)		0-20	0-40	0-60	0-10	0-20	0-40	0-60
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.01% of Full Range							
Current Range (Adc)								
@ 55°C	0-Io Max.	0-12	0-6	0-4	0-25	0-25	0-12	0-8
@ 71°C		0-67% Io Max	0-67% Io Max	0-67% Io Max	0-77% Io Max	0-50% Io Max	0-67% Io Max	0-67% Io Max
Current Mode:								
Current Range:	Same as in Voltage Mode.							

Table 1-3 Convection Cooled Unit Specifications (Sheet 2 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Current Range (cont)								
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.015% of Full Range							
Voltage Compliance	Full Voltage Range							
Crossover Characteristics	Figure 6-6 (Section 6)							
PERFORMANCE								
Voltage Mode:								
Regulation [1]	0.01% or 2 mV							
PARD (ripple) 50-60Hz input:[2]								
Max. RMS, 10Hz-7MHz (μV)		200	200	300	350	300	300	300
Max. P-P, 0-25MHz (mV, grounded output)		30	30	30	20	30	30	30
Transient Response (typ. recovery time-μSec)[3]		30 30	30 30	70 70	150 150	150 150	150 150	70 70
Output Impedance								
Typical	Figure 6-5 (Section 6)							
Low Freq. (R & JwL):								
R=(μOhms)		80	320	750	20	40	170	375
L=(μHy)		1.3	1.0	0.8	1.0	0.8	1.6	0.8
Temp. Coefficient	0.01% +200 μV/°C							

[1]For a combined full line swing, and a NF-FL (no load-to-load) or FL-NL change.
[2]With chassis tied to ground.
[3]For a step load change of NL-FL or FL-NL, recovery to ± 10mV band.

Table 1-3 Convection Cooled Unit Specifications (Sheet 3 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Drift (typical)[1]	0.025% + 500μV							
Remote Programming								
Prgrm. Constant:								
Res. (ohms/volt)[2]	200±0.5%							
Volt.Gain (volt/-volt)[3]	1							
Remote Sensing	1V/Load Lead							
Overload Protection	Crossover to Current Mode							
Output voltage Over-Shoot	None							
Current Mode:								
Regulation, full line and load (mA)	0.02% + B, where B= :	4	1	1	4	4	4	1
PARD (ripple) 50-60Hz input:								
Max. RMS 10Hz-7MHz (mA) Full Compliance (FC)		3	0.5	0.5	10	10	1	1

[1]For 8hrs after warmup, @ constant line voltage, load and ambient temperature.
[2]Can be varied.
[3]Can be varied-signal source can be connected to negative output.

Table 1-3 Convection Cooled Unit Specifications (Sheet 4 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Output Impedance (typ)	Figure 6-5 (Section 6)							
Temperature Coeff. (/°C) (typ)	0.01% + C Where C=	1mA	0.5mA	0.5mA	1mA	1mA	1mA	1mA
Drift (after 8hrs warmup) (typ)	0.03% + 3mA							
Remote Programming								
Prgrm. Constant:								
Res. (ohms/amp)		80±10%	150±10%	250±10%	40±10%	40±10%	80±10%	125±10%
Voltage (volts/amp)		0.08±10%	0.150±10%	0.25±10%	0.02±10%	0.02±10%	0.08±10%	0.125±10%
Overload Protection	Crossover to Voltage Mode							
Output Current Overshoot	None							
SPECIFICATIONS (MISC.)								
Overvoltage Protection								
Crowbar: Response Time (typ)[1]	To Erated (typ) +6V, 50 µSec							

[1]10uSec response can be achieved by removing C51, although nuisance tripping may result.

Table 1-3 Convection Cooled Unit Specifications (Sheet 5 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
Crowbar (cont)								
Temperature Coeff. (typ)	0.05%/°C							
Open Sensing Protection	Yes							
Reverse Voltage Protection	Yes							
Ambient Temperature Range	0°C-71°C							
Derate Per Characteristics	Figure 6-6 (Section 6)							
Series Operation (direct connection or master-slave	Up to 200 Vdc Output							
Parallel Operation (by current limiting feature or master-slave)	Up to 3 Units							
Cooling	Convection							
Isolation Voltage to Ground:								
Input	1000Vdc							
Output	200Vdc							

Table 1-3 Convection Cooled Unit Specifications (Sheet 6 of 6)

	ALL	20-12	40-6	60-4	10-25	20-25	40-12	60-8
MECHANICAL DATA								
Size in. (mm):								
Width	19(483)							
Height		3-15/32(88)	3-15/32(88)	3-15/32(88)	5-7/32(133)	5-7/32(133)	5-7/32(133)	5-7/32(133)
Depth	17-3/4(451)							
Weight lbs. (kg)		45(20.4)	44(20)	44(20)	64(29)	64(29)	64(29)	64(28)
AC Input Connections	Line Cord							

Table 1-4 Fan Cooled Unit Specifications (Sheet 1 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
INPUT RATINGS	105-125V (Standard) 190-230V (M1 Option)						*	*
Voltage Range	210-250V (M2 Option)							
Frequency	47-53/57-63Hz							
Phase	1							
Current (Adc Max)								
@ 115Vac		14.7	22	22	32.5	28	N/A	N/A
@ 210Vac		8	12	12	18.5	15.4	25	26
@ 230Vac		7.3	11	11	16.3	14	23	24
Power Factor (typical)		0.73	0.675	0.685	0.66	0.64	0.66	0.6
Efficiency (typ)		42.4%	59.7%	61.7%	45.5%	53.6%	62.5%	67.8%
OUTPUT RATINGS								
Voltage Mode:								
Voltage Range (Vdc)		0-10	0-40	0-60	0-10	0-20	0-40	0-60
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.01% of Full Range							
Current Range (Adc)								
@ 55°C	0-Io Max.	0-50	0-25	0-17	0-100	0-50	0-50	0-35
@ 71°C	0-67% Io Max.							
Current Mode:								
Current Range:	Same as in Voltage Mode.							

*105 - 125-volt input not provided. 190-230V (standard).

Table 1-4 Fan Cooled Unit Specifications (Sheet 2 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Current Range (cont)								
Coarse	Full Range							
Fine	1% of Full Range							
Resolution (typ)	0.015% of Full Range							
Voltage Compliance	Full Voltage Range							
Crossover Characteristics	Figure 6-6 (Section 6)							
PERFORMANCE								
Voltage Mode:								
Regulation [1]	The greater of 0.01% or 2 mV							
PARD (ripple) 50-60Hz input:[2]								
Max. RMS, 10Hz-7MHz (μV)		300	500	500	300	500	700	700
Max. P-P, 0-25MHz (mV, grounded output)		25	40	25	20	40	40	40
Transient Response (typ. recovery time-μSec)[3]	150 μSec							
Output Impedance								
Typical	Figure 6-5 (Section 6)							
Low Freq. (R & JwL):								
R=(μOhms)		10	80	180	5	20	40	85
L=(μHy)		0.5	1.2	1.6	0.3	1.6	0.8	1.6
Temp. Coefficient	0.01% +200 μV/°C							

[1]For a combined full line swing, and a NF-FL (no load-to-load) or FL-NL change.
[2]With chassis tied to ground.
[3]For a step load change of NL-FL or FL-NL, recovery to ± 10mV band.

Table 1-4 Fan Cooled Unit Specifications (Sheet 3 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Drift (typical)[1]	0.025% + 500μV							
Remote Programming								
Prgrm. Constant:								
Res. (ohms/volt)[2]	200±0.5%							
Volt.Gain (volt/-volt)[3]	1							
Remote Sensing	1V/Load Lead							
Overload Protection	Crossover to Current Mode							
Output voltage Over-Shoot	None							
Current Mode:								
Regulation, full line and load (mA)	0.02% + B, where B= :	4	4	4	6	4	4	4
PARD (ripple) 50-60Hz input:								
Max. RMS 10Hz-7MHz (mA) Full Compliance (FC)		20	10	3	35	10	10	10

[1]For 8hrs after warmup, @ constant line voltage, load and ambient temperature.
[2]Can be varied.
[3]Can be varied-signal source can be connected to negative output.

Table 1-4 Fan Cooled Unit Specifications (Sheet 4 of 6)

	ALL	10-50	40-25	60-17	10-100	20-50	40-50	60-35
Output Impedance (typ)	Figure 6-5 (Section 6)							
Temperature Coeff. (/°C) (typ)	0.01% + C Where C=	1mA	1mA	1mA	2mA	1mA	1mA	1mA
Drift (for 8 hrs after warmup) (typ)	0.03% +D where D=	3mA	3mA	3mA	10mA	3mA	3mA	3mA
Remote Programming								
Prgrm. Constant:								
Res. (ohms/amp)		20±10%	40±10%	60±10%	10±10%	20±10%	20±10%	28±10%
Voltage (volts/amp)		0.08±10%	0.02±10%	0.04±10%	0.0025 ±10%	0.08±10%	0.008±10%	0.015±10%
Overload Protection	Crossover to Voltage Mode							
Output Current Overshoot	None							
SPECIFICATIONS (MISC.)								
Overvoltage Protection								
Crowbar: Response Time (typ)[1]	To Erated (typ) +6V, 50 µSec							

[1]10 µSec response can be achieved by removing C51, although nuisance tripping may result.

SECTION 2

INSTALLATION

2.1 GENERAL

After unpacking, initial inspections and preliminary checkout procedures should be performed to assure that unit is in good working order. Basically, these consist of visually checking for damaged parts and components, and making an electrical check. Procedures are given in this section to check the unit in voltage and current modes of operation. If it is determined that the unit is damaged, the carrier should be notified immediately. The carrier claim agent will then prepare a report of damage. The user is required to send this report to the Service Dept., Sorensen Company, 676 Island Pond Road, Manchester, New Hampshire, 03103. Sorensen Company will advise the user as to what action is required to repair or replace the supply.

2.2 INITIAL INSPECTION

Proceed as follows to inspect for damage incurred during shipment, prior to applying ac power:

1. Inspect panel and chassis for dents, paint chips and obvious signs of structural damage.

2. For units with rear mounted fuseholder, assure that holder contains a properly rated fuse. Fuse ratings for both 115 and 220/230 Vdc inputs appear above the holder.

3. Turn front panel controls from stop to stop. Rotation should be smooth.

4. Set POWER switch to ON and then OFF, then test OVERVOLTAGE switch for proper mechanical action.

5. Check for cracked or broken indicator lamp lens.

6. Inspect for cracked meter windows. If pointer is off zero, reset using adjust screw. (To minimize effects of static electricity causing deflection, touch meter window and chassis with fingers of one hand).

7. Check input cord for physical damage. Tug lightly on cord near chassis to make certain relief grommet grips cord.

8. Inspect terminal boards. On TB2, links should be firmly connected across terminals 1, 2, 3 and 4, 7 and 8, 9 and 10. Check that sensing leads are properly connected between TB3-1 and TB2-5, and TB3-3 and TB2-6.

9. Remove screws retaining top cover to chassis. Inspect printed circuit board and components for damage.

Unit mounting and installation dimensions are shown in figures 2-1, 2-2, and 2-3.

2.3 ELECTRICAL INSTALLATION

Sorensen's high power SRL models 40-50 and 60-35 are factory wired for 190-230 Vac inputs (order M2 for 210-250 Vac input). Other models of SRL power supplies are factory wired to accept 105-125 Vac (standard model), 190-230 Vac (M1 model) or 210-250 Vac (M2 model). Low power units are provided with a factory wired power cord. This cord terminates externally in a three prong polarized plug through the line cord, and therefore insertion of the plug into a compatible receptacle will automatically ground the unit. If a grounded input is not available, use an adapter, making sure that the external lead of the adapter is well grounded. For units not equipped with a line cord intact, connect 3 wire input leads to terminals 1, 2 (GRD) and 3 on input terminal board TB1 at the rear of the supply.

CAUTION

If chassis is not grounded, case will be at approximately 55 Vac due to RFI capacitors connected between AC line and chassis. This can produce an unpleasant (although not dangerous) electrical shock.

2.4 ELECTRICAL INSPECTION

The following paragraphs describe the procedure for making an initial electrical inspection. If specification verification is required, refer to section 5, Maintenance.

2.4.1 Voltage Mode

To check voltage mode operation, proceed as follows:

1. Rotate COARSE CURRENT control and COARSE VOLTAGE controls fully counterclockwise.
2. Rotate FINE CURRENT control fully clockwise.

NOTE

Do not loosen or remove interconnecting links of terminal boards.

3. Insert power cord into a suitable receptacle, and set POWER switch to ON.
4. Slowly rotate the COARSE VOLTAGE control clockwise. Minimum range should be from 0 to maximum rated output voltage (table 1-3 or 1-4).
5. Set POWER switch to OFF.

2.4.2 Current Mode

To check current mode operation, proceed as follows:

1. Rotate COARSE VOLTAGE control and COARSE CURRENT controls fully counterclockwise.

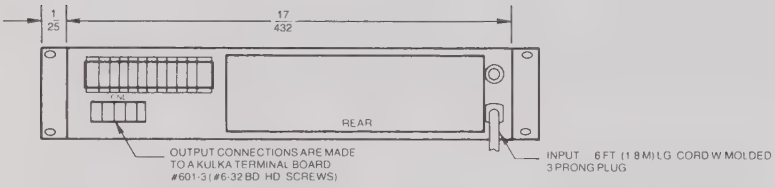
2. Turn FINE VOLTAGE control fully clockwise.

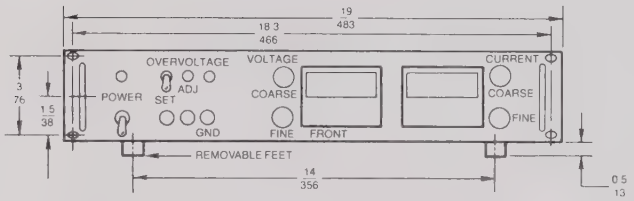
3. Short output terminals, using appropriate size wire. (rear terminals only for units of 25 amperes and above).

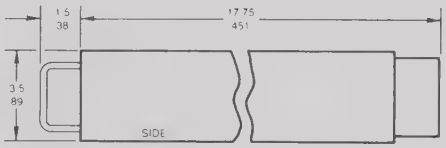
4. Set POWER switch to ON.

5. Rotate COARSE CURRENT control slowly clockwise. The control range should be from "0" to the maximum rated output (table 1-3 or 1-4).

6. Set POWER switch to OFF.





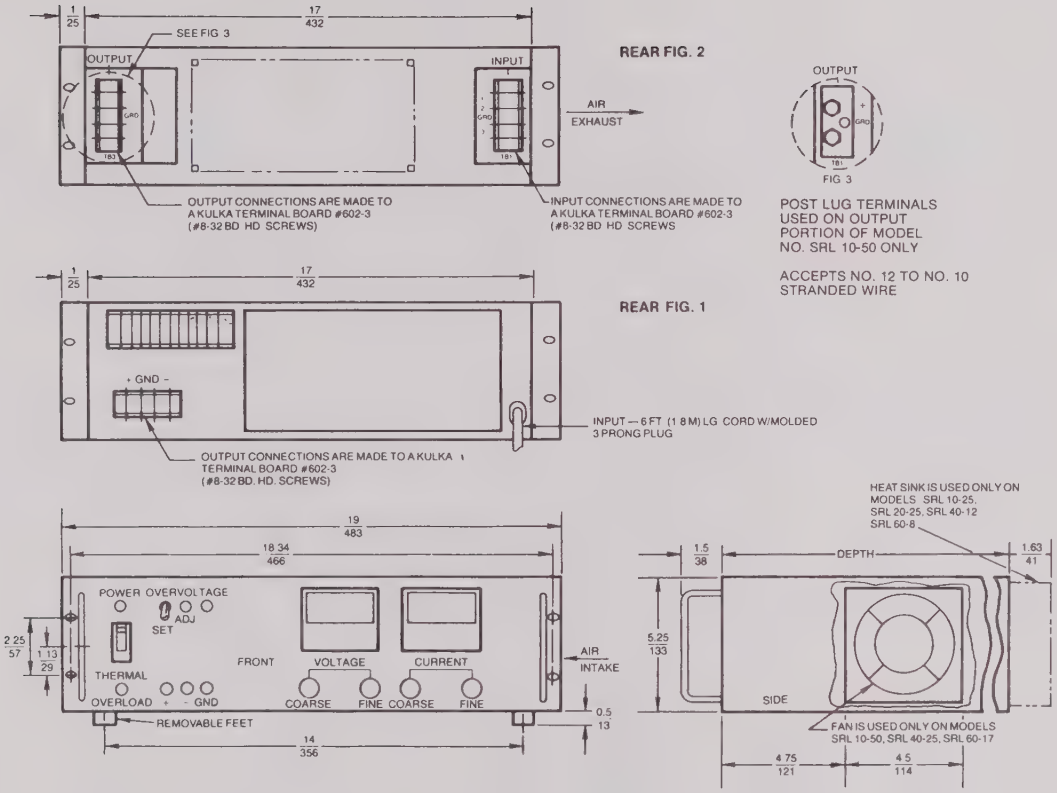


Model	Weight lbs (kg) Net
SRL 20-12	45 (20.4)
SRL 40-6	44 (20.0)
SRL 60-4	44 (20.0)

ALL DIMENSIONS ARE IN INCHES / MM

Dwg No. E585325
Rev.-

Figure 2-1 SRL Outline Drawing 3 1/2" Panel Series


SEE FIG 3
OUTPUT
INPUT
AIR EXHAUST
OUTPUT CONNECTIONS ARE MADE TO A KULKA TERMINAL BOARD #602-3 (#8-32 BD HD SCREWS)
INPUT CONNECTIONS ARE MADE TO A KULKA TERMINAL BOARD #602-3 (#8-32 BD HD SCREWS
REAR FIG. 2
REAR FIG. 1
+ GND -
INPUT — 6 FT (1.8 M) LG CORD W/MOLDED 3 PRONG PLUG
OUTPUT CONNECTIONS ARE MADE TO A KULKA TERMINAL BOARD #602-3 (#8-32 BD. HD. SCREWS)
POWER OVERVOLTAGE
ADJ
SET
THERMAL
OVERLOAD + - GND
FRONT
VOLTAGE
CURRENT
COARSE FINE COARSE FINE
AIR INTAKE
REMOVABLE FEET
HEAT SINK IS USED ONLY ON MODELS SRL 10-25, SRL 20-25, SRL 40-12 SRL 60-8
DEPTH
SIDE
FAN IS USED ONLY ON MODELS SRL 10-50, SRL 40-25, SRL 60-17
OUTPUT
FIG 3
POST LUG TERMINALS USED ON OUTPUT PORTION OF MODEL NO. SRL 10-50 ONLY
ACCEPTS NO. 12 TO NO. 10 STRANDED WIRE

Model	Depth	Rear View	Weight lbs (kg) Net
SRL 10-25	16.2 (409)	Fig. 1	64 (29)
SRL 10-50	21 (533)	Fig. 2	81 (36)
SRL 20-25	16.2 (409)	Fig. 1	64 (29)
SRL 40-12	16.2 (409)	Fig. 1	64 (29)
SRL 40-25	21 (533)	Fig. 2	95 (43)
SRL 60-8	16.2 (409)	Fig. 1	64 (29)
SRL 60-17	21 (533)	Fig. 2	95 (43)

NOTES: ALL DIMENSIONS ARE IN INCHES / MM

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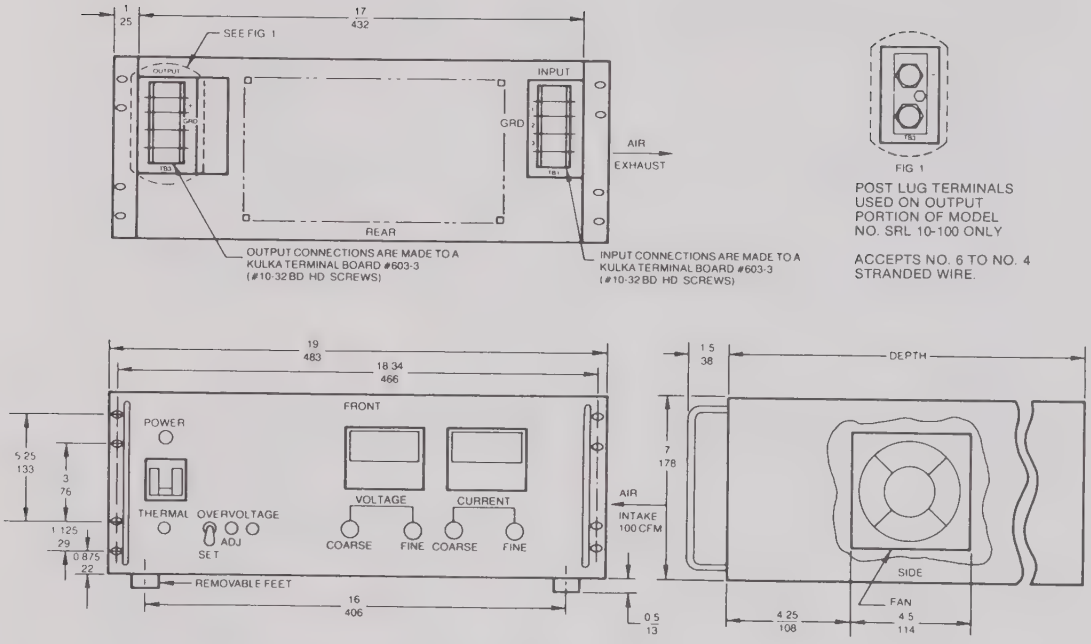
Rev. -

Figure 2-2 SRL Outline Drawing 5 1/4" Panel Series



Model	Depth	Weight lbs (kg) Net
SRL 10-100	23 (584)	132 (60)
SRL 20-50	21 (533)	128 (58)
SRL 40-50	21 (533)	120 (54)
SRL 60-35	21 (533)	120 (54)

NOTES: ALL DIMENSIONS ARE IN INCHES
MM

Figure 2-3 SRL Outline Drawing 7" Panel Series

SECTION 3

OPERATION

3.1 GENERAL

In this section, procedures required to convert an SRL unit to any of its various operating configurations are presented, including local and remote sensing, voltage and current mode programming, and series and parallel operation. Unit controls and indicators have been illustrated and described in section 1.

3.2 VOLTAGE MODE OPERATION

3.2.1 Local Sensing

All models in the SRL series are shipped ready for use with local sensing, i.e., sensing point is at the output terminals. If variations in load lead drops are expected to be high relative to unit's specified regulation, remote sensing should be used (paragraph 3.2.2).

To operate unit in local sensing, proceed as follows:

1. To set current limit value, short the unit output terminals. Set panel CURRENT control to zero (fully counterclockwise). Set POWER switch to ON, and use CURRENT control to adjust current limit value, not to exceed 110% of rated current.

2. Set POWER switch to OFF, remove short.

3. Apply input power, and rotate COARSE and FINE VOLTAGE controls to obtain desired output. Set POWER switch to OFF.

4. Observing polarity, run load leads to either front or rear output terminals. At rear terminals, link should be fitted between binder screw head and lead.

NOTE

Some models do not include front panel output terminals.

5. Set POWER switch to ON.

3.2.2 Remote Sensing

To adapt unit for remote sensing operation, follow procedures outlined in paragraph 3.2.1. Before setting POWER switch to ON, remove wire sense leads between terminals TB3-1 and TB2-5 and TB3-3 and TB2-6. Then connect sensing leads, observing polarity, to TB2-5 and TB2-6. Use coaxial cable or a twisted pair of wires for sensing leads and make certain that the leads are firmly connected to unit terminals and load. Current in the sensing leads is below 100 mA. In remote sensing, standard programming operation, transient response characteristics may degenerate slightly.

3.2.3 Remote Programming

In voltage mode, remote programming operation, unit output voltage is controlled by external resistance or voltage signal commands. Either type may be used.

3.2.3.1 Resistance Programming

If the output voltage is to be controlled by resistance programming, calculate the resistance required using the ratio of 200 ± 0.5 ohms per volt, that is for every volt of output desired approximately 200 ohms are required. In selecting a programming resistor, choose one with a low temperature coefficient (±20 ppm/°C) and a wattage at least twice that calculated (programming current is normally 5 mA).

Note that resistance programming may also be used to improve the unit drift characteristic. For example, if a fixed output is required, a fixed resistor may be selected. This eliminates the variable contact resistance which is inherent in any potentiometer and which contributes to the drift characteristic. If abrupt changes in output voltage are to be made by switching the programming resistance, use a make-before-break switch.

To adapt unit to resistance programming, proceed as follows:

a. Short unit output terminals with current control set to zero (CCW). Set POWER switch to ON. Use the CURRENT control to adjust current limit value.

b. Set POWER switch to OFF, remove short.

c. Rotate VOLTAGE controls fully counterclockwise.

d. Remove link between terminals TB2-3 and TB2-4, and connect programming resistor. Use twisted or shielded wire for leads.

NOTE

Operating the unit with open programming leads or links may result in either low or high output voltage.

With the programming resistor connected across terminals TB2-3 and TB2-4, the VOLTAGE control remains in the circuit. Rotation of this control will alter the programmed voltage. If this is undesirable, connect the resistor across terminals TB2-3 and TB2-6 to effect complete bypass. If step changes in output voltage are to be made by abrupt resistance alterations, use make-before-break switching.

3.2.3.2 Changing of Programming Constant

If it becomes desirable to change the programming constant, the value of R21 (programming constant resistor) may be determined as in the following example.

Example: To change the programming coefficient (Pc) from 200 ohms per volt to 1000 ohms per volt, calculate the new value of R21:

$$R21 = Vref \times Pc$$

where Vref is the voltage across C11 (approximately 9 volts). thus;

$$R21 = 9 \text{ volts} \times 1000 \text{ ohms/volt} = 9000 \text{ ohms}$$

The current through R21 is then $\frac{9 \text{ volts}}{9000 \text{ ohms}} = 1$ milliampere.

As noted before, the programming resistor should have a low temperature coefficient and a wattage rating at least twice that of the calculated rating.

To adapt unit to a different resistance programming constant, proceed as follows:

a. Rotate VOLTAGE controls fully counterclockwise.

b. Remove the link between TB2-1 and TB2-2. Install programming constant resistor R21 between TB2-1 and TB2-3 and adjust Vref until the ratio of Vref/R21 is exactly 1 milliampere, or the calculated reference current. This can be done by inserting a resistor in place of R53A (between TB2-3 and TB2-6, with TB2-3 and TB2-4 open) equal to Eout max/1mA and adjusting the voltage reference potentiometer R9 until Eout is exactly equal to Eout max.

c. Deterioration of the voltage regulation will occur as the programming constant is increased, due to the effect of the offset current, and will be proportional to the increase of R21. As an example, if the contribution due to offset current at 200 ohms per volt is 0.002%, at 1000 ohms per volt approximately 0.01% contribution to regulation might be expected.

3.2.3.3 Voltage Signal Programming

To adapt unit for voltage signal programming proceed as follows:

a. Unity Gain (1V/V) (Figure 3-1)

1) Remove the input power.

2) Remove the link between TB2-1 and TB2-2.

3) Remove the link between TB2-3 and TB2-4.

4) Connect the signal programming source between TB2-3 and TB2-6 using a series resistor Ri as shown on Figure 3-1. Select Ri based on the rated maximum voltage of the SRL and 200 ohms per volt (e.g., 60V SRL units will use Ri of 12K). Use a precision 1/2 watt resistor such as the RL 20S type. Observe the proper polarity of signal source (negative) on TB2-6.

5) With this modification, the SRL will produce a one volt output for one volt of signal. Do not exceed the rated output voltage of the SRL.

NOTE

The stability and regulation will be a function of the signal source stability. This source requires an output current rating of 5mA dc, with its output floating (ungrounded).

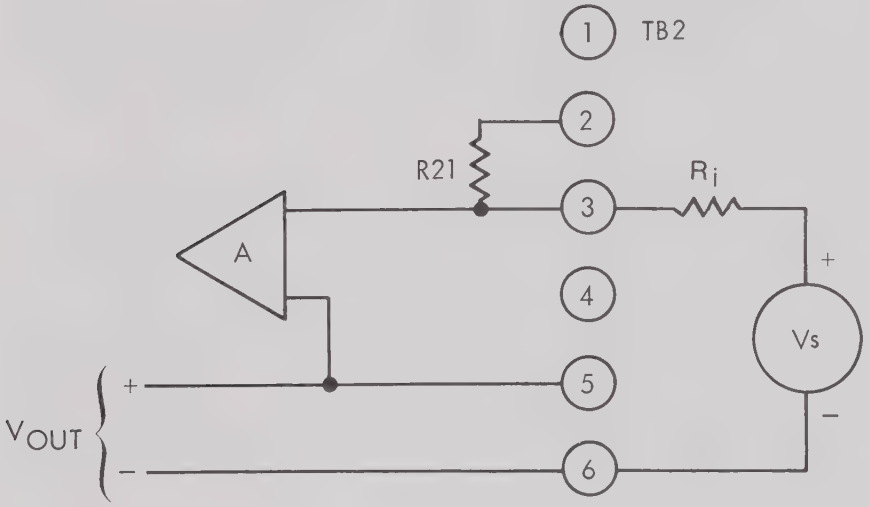


Figure 3-1 Unity Gain

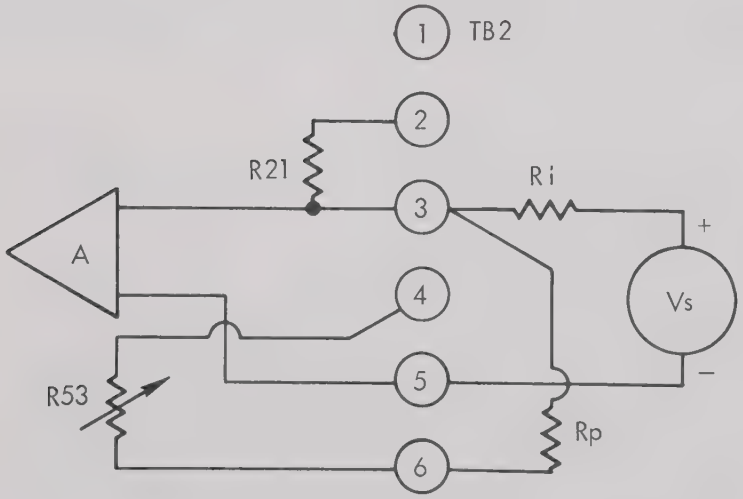


Figure 3-2 Variable Gain

b. Variable Gain (Figure 3-2)

1) Remove the link between TB2-1 and TB2-2.

2) Remove the link between TB2-3 and TB2-4.

3) Place Ri (1.78K suggested) in series with the signal source and connect as shown in Figure 3-2 between TB2-3 and TB2-5, observing the proper polarity.

4) As with the previous method of programming, stability will be a function of the signal source stability, its internal impedance, and the stability of Ri and Rp.

In this mode of operation Vo = Vs Rp/Ri assuming the effects of amplifier offset and signal source impedance are negligible. Thus the gain is determined by the ratio Rp/Ri. It is suggested that Ri be made equal to 1.78 kohm or less to minimize the effect of offset voltage. Ri and Rp should be stable resistors (10 ppm/°C or less). Note that the front panel VOLTAGE control R53 may be substituted for Rp if TB2-3 and TB2-4 are linked.

3.3 CURRENT MODE OPERATION

To operate an SRL unit in the current mode, proceed as follows:

1. Rotate all front panel controls fully counterclockwise.

2. Short the output terminals.

3. Rotate FINE VOLTAGE control clockwise, and close POWER switch.

4. Turn COARSE and FINE CURRENT controls clockwise to select the desired output current.

5. Open POWER switch and remove short from output terminals.

6. Set POWER switch to ON and adjust output voltage to desired compliance setting.

7. Open POWER switch, and observing polarity, connect load to terminals TB3-1 and TB3-3. Reapply input power.

NOTE

If compliance voltage exceeds voltage control setting, crossover to voltage mode operation occurs automatically.

3.3.1 Remote Programming

In current mode, remote programming operation, the regulated output current may be controlled externally by resistance changes or voltage signals.

3.3.1.1 Resistance

For resistance programming, calculate the value of resistor required by using the ohms/ampere coefficient listed in Table 3-1.

Table 3-1 Programming Constants (Current Mode)

SRL Model	Resistive Ohms/Ampere (±10%)	Voltage Millivolts/Ampere (±10%)
10-25	40	20
30-12	80	80
20-25	40	20
40-6	150	150
40-12	80	80
60-4	250	250
60-8	125	125
10-50	20	8
10-100	10	2.5
20-50	20	8
40-25	40	20
40-50	20	8
60-17	60	40
60-35	28	15

Note: Use a resistor with a low temperature coefficient (±20 ppm/°C), and a wattage rating at least twice that of the calculated value (normal programming current is approximately 1 milliampere).

To adapt unit for current mode, resistance programming operation, proceed as follows:

a. Close POWER switch, adjust output voltage to desired compliance setting.

b. Open POWER switch and rotate CURRENT controls fully counter-clockwise.

c. Remove link between terminals TB2-7 and TB2-8, and replace with programming resistor.

CAUTION

Operating unit with open programming leads or links will result in high output current with possible crossover to voltage mode. If step changes in output current are to be made by abrupt resistance alterations, use make-before-break switching.

---

d. Run load to terminals TB3-1 and TB3-3, observing polarity.

e. Set POWER switch to ON. Unit supplies regulated programmed current to the load.

NOTE

Any rotation of the CURRENT control alters the output current. Dangerous output currents may result. The panel current knobs may be removed if desired.

3.3.1.2 Voltage Signal

To adapt an SRL unit to voltage signal programming, connect the programming device as shown in Figure 3-3 and follow the procedure listed below. This method will alleviate the possibility of damage to the equipment by inadvertent application of too high a programming voltage by presetting a current limit "threshold".

The external program power supply must have an OP-AMP output, capable of sinking 1 mA through CR1. External sense must be used as shown. Do not ground either the positive or negative terminals of the program power supply.

See Unit Specifications Table 1-3 or 1-4, CURRENT MODE AMPS/AMP heading for the program constant. (The full scale voltage varies from 250 mV to 1V depending on model.

NOTE

CR2 and CR3 are used to clamp the + program terminal from exceeding negative 1.5 volts to protect the SRL.

CAUTION

Do not program SRL current by direct connection between the program power supply and the SRL. This will defeat the SRL power limiting circuit. (See Section 4, para. 4.3).

CAUTION

Do not rotate the panel current adjust controls from the OFF position since dangerous SRL output current may result when overloaded.

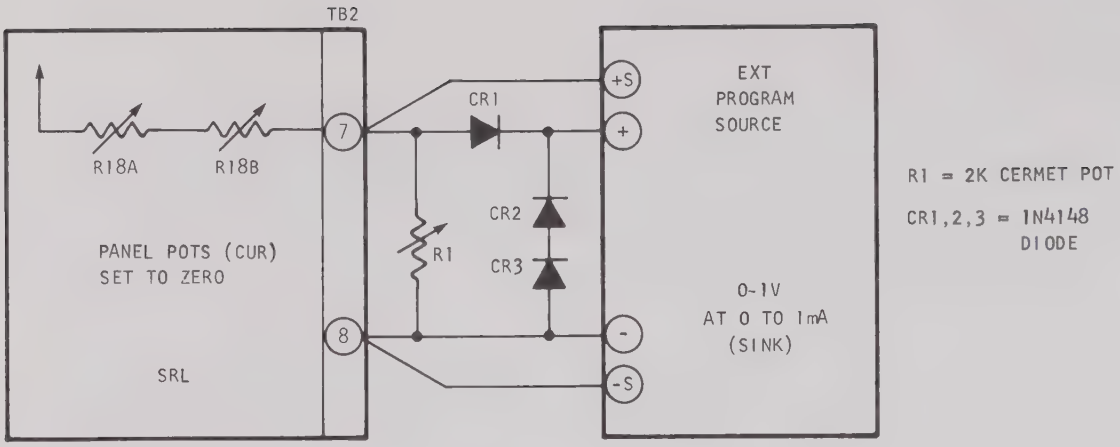


Figure 3-3 Current Programming by Voltage Signal

Procedure:

1. Set the front panel current controls (R18A and R18B) fully counter-clockwise (OFF). The control knobs should be removed to prevent accidental use.
2. With the program power supply OFF, and the (+S) lead disconnected from the program power supply, short the SRL output terminals. Set R1 trimmer at 50% rotation.
3. Turn the SRL ON. Adjust R1 trimmer for 110% of rated output current.
4. Turn the SRL OFF. Reconnect the (+S) lead to the program power supply and turn it ON. Turn the SRL ON.
5. The external program power supply must have an op-amp output, capable of sinking 1 mA through CR1. External sense must be used as shown. Do not ground either (+) or (-) terminal of external program power supply.
6. See unit specification Table 1-2 "CURRENT MODE VOLTS/AMP" for program constant. (The full scale voltage varies from 250 mV to 1V depending on model).
7. Note that overvoltage from the program power supply will not exceed the preset maximum I_{out} (as set by R1 trimmer).

3.4 SERIES OPERATION

For applications which require voltages higher than a single SRL model can provide, series operation may be utilized. The maximum rated output of any series connected system is 200 Vdc. System regulation is the sum of the regulations for all units. In SRL models, there is no need to connect reverse voltage rectifiers across the output terminals. Reverse voltage protection has been designed in.

3.4.1 Local Sensing Figure 3-4 (a)

To connect units in series with local sensing, proceed as follows:

1. Adjust the output voltage of each unit so that their sum is equal to the desired system output. Set POWER switches of each unit to OFF.

2. Disconnect links between terminals TB3-1 and TB2-5, and TB3-3 and TB2-6 of each unit.

3. Reconnect load and sensing leads as shown in figure 3-4, (a).

4. Set POWER switches to ON. The system supplies regulated voltage to the load.

3.4.2 Remote Sensing Figure 3-4 (b)

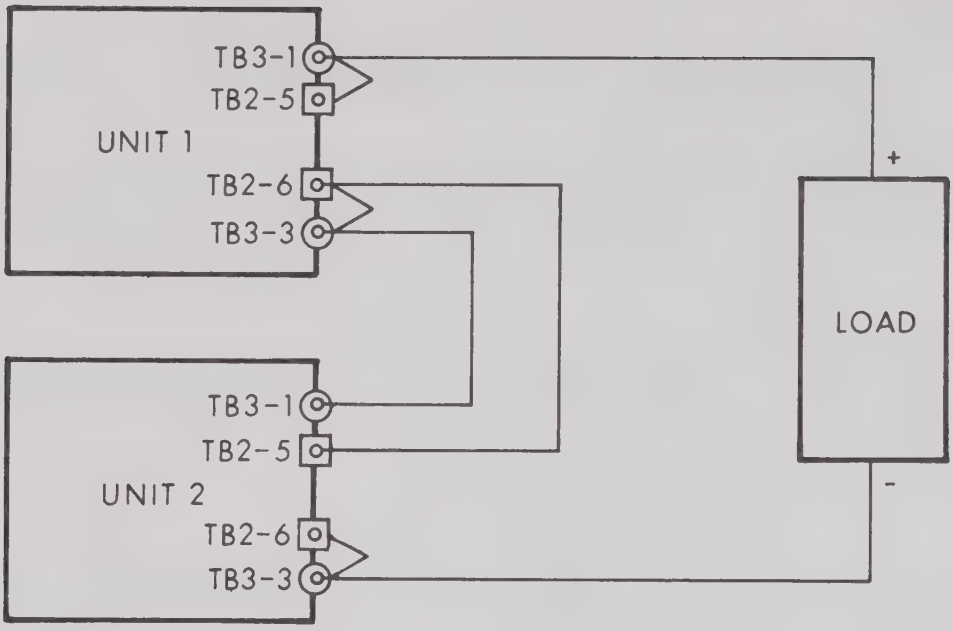
To connect units in series, remote sensing, remove leads from terminals TB2-5 and TB2-6. Observing polarity, connect coaxial cable or a twisted pair of wires from TB2-5 and TB2-6 across load as shown.

NOTE

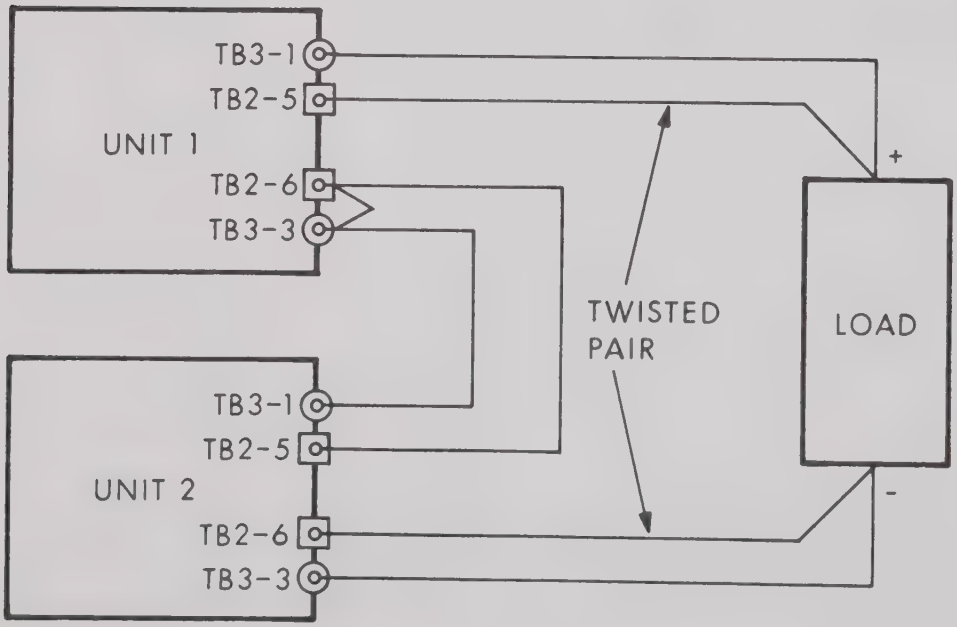
Wherever possible, use twisted or shielded leads. At load and unit terminals, place sensing leads between binder screwhead and load lead.

3.5 PARALLEL OPERATION

Parallel operation may be used to obtain currents greater than any single model can supply. Up to three units may be connected in this manner. The maximum rated output of any parallel connected system is the sum of the maximum outputs of each unit, derated to 90%.

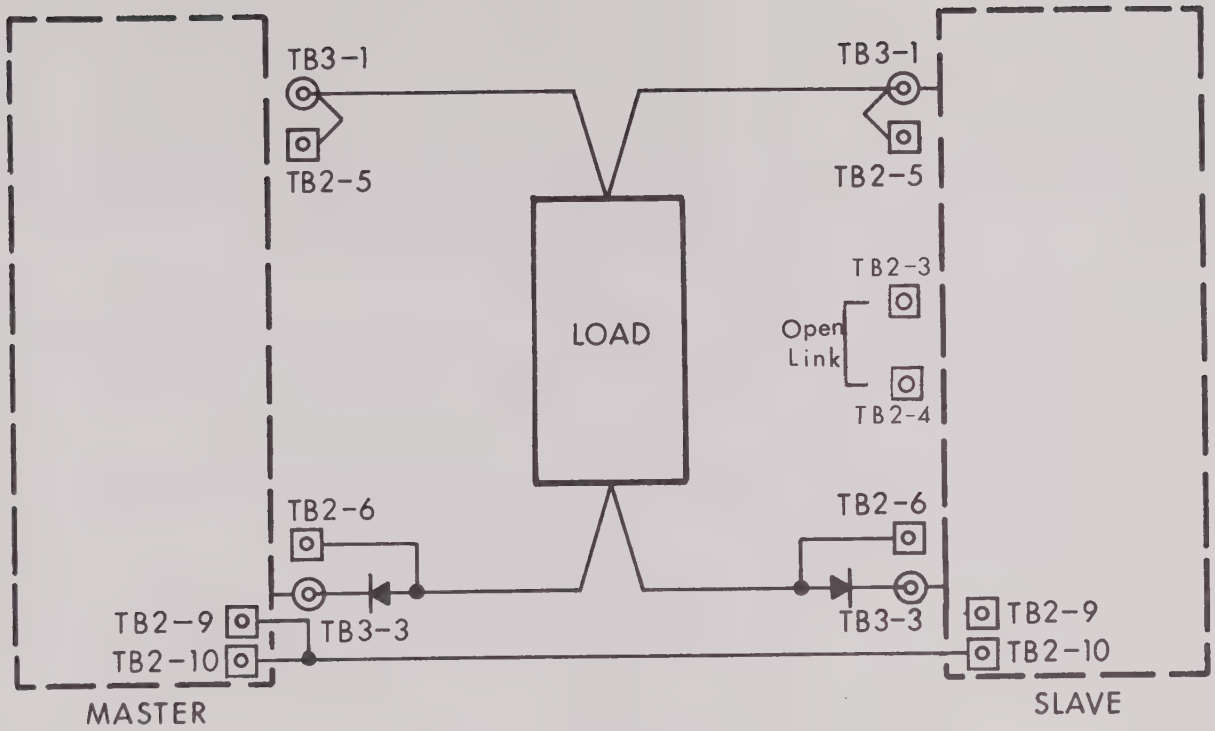


(a) Local Sensing - Series Operation

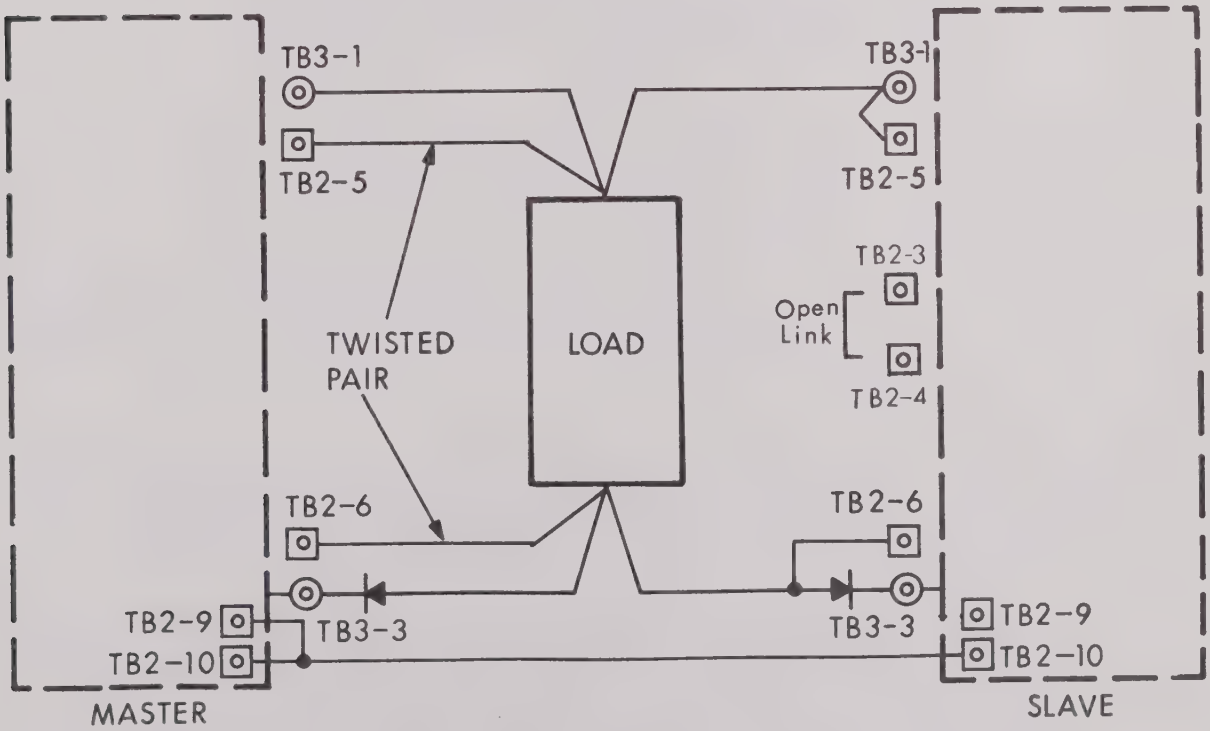


(b) Remote Sensing - Series Operation

Figure 3-4 Series Operation



(a) Local Sensing - Parallel Operation



(b) Remote Sensing - Parallel Operation

Figure 3-5 Parallel Operation

3.5.1 Local Sensing Figure 3-5 (a)

To connect additional units in parallel with local sensing, proceed as follows:

1. Apply nominal input power to MASTER unit, and adjust output to desired load voltage. Set POWER switch to OFF.

2. Short master unit output terminals and apply input power. Adjust output current to Io/X, where Io is the total system output current, and X is the number of units in the system. Set POWER switch to OFF.

3. At SLAVE units, remove links from across terminals TB2-3 and TB2-4, and TB2-9 and TB2-10. Connect a lead between TB2-10 terminals of each unit.

4. Observing polarity, run leads from the load to terminals TB3-1 and TB3-3 on each unit, with (2) diodes connected as shown in (a) of figure 3-5.

NOTE

Assure the diodes have a current capability at least equal to its associated supply. Connect anode to load in each case. A suitable heatsink is required for each diode.

5. On each unit, open lead between terminals TB2-6 and TB3-3, and connect a lead from TB2-6 to the anode of the diode.

3.5.2 Remote Sensing Figure 3-5 (b)

For remote sensing, remove existing leads from terminals TB2-5 and TB2-6. Observing polarity, connect coaxial cable or twisted pair of wires from TB2-5 and TB2-6 of master unit across load as shown.

3.5.3 Overvoltage Protection (OVP)

A special circuit in the SRL series allows the operator to set the desired overvoltage trip point without disturbing the voltage output of the supply. This feature enables the trip point to be set and verified even with the load connected. Proceed as follows:

1. Depress the OVERVOLTAGE SET toggle switch on the front panel. The panel voltmeter will then indicate the OVP trip voltage, instead of the unit output voltage.

2. Adjust the recessed overvoltage ADJ screw on the front panel until the voltmeter indicates the desired trip voltage.

3. Release the toggle switch.

Overvoltage indicator DS2 will illuminate when the OVP preset limit has been exceeded by power supply output, and remains on until the OVP circuit is reset. Resetting is accomplished by placing the unit POWER switch to OFF momentarily. To avoid nuisance tripping, it is recommended that the OVP trip point be set at least 10% above the desired output voltage, but not less than 1 volt.

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

This section discusses the basic theory of series pass regulation, describes the block functions of various circuits and then details the operation of each circuit. If used as a supplement to the troubleshooting data provided in section 5, it will aid in the isolation of unit faults. Schematic locations and reference designations used throughout this section will be found in figure 6-2.

4.2 SCR PREREGULATED SERIES PASS PRINCIPLE

The SRL utilizes a combination of SCR preregulation and series pass principles to regulate unit output. The series pass function utilizes a variable impedance to absorb the difference between the filtered dc and the desired output voltage in the voltage mode, and the compliance voltage in the current mode. The variable impedance is provided by a number of transistor stages connected in parallel, all of which react simultaneously to an output related control signal. Operation of the transistors, which are called passing stages, is illustrated in Figure 4-1.

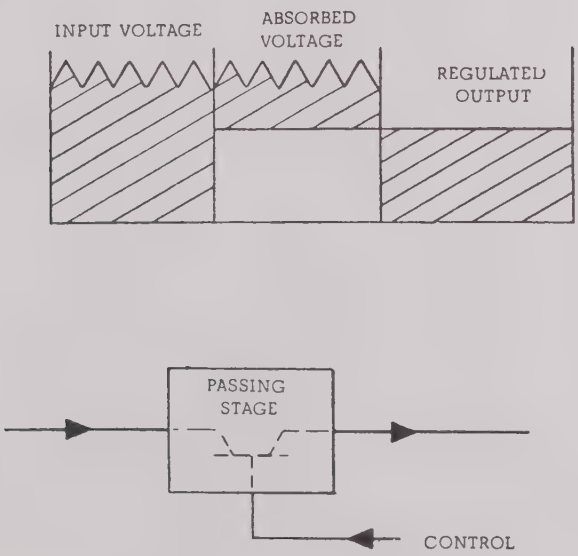


Figure 4-1 Series Pass Principle

For wide range power supplies such as those in the SRL series, the series pass regulator becomes less practical at higher power output levels. This is due to excessive voltage stored in the passing stage transistor at lower supply output voltages. The method used to restrict the power dissipated in the passing stage is preregulation, utilizing a pair of silicon-controlled rectifiers (SCR) whose outputs are controlled to maintain a constant dc voltage across the passing stage. (Paragraph 4.3.6 describes the operation of the preregulator circuit).

4.3 SRL POWER SUPPLY THEORY

NOTE

For this system level discussion refer to the block diagram (Figure 4-2) and system schematic in section 6 (Figure 6-2).

Input power is applied through a phase controlled SCR circuit consisting of CR 15/16, which function as part of the system preregulator circuit, to input transformer T1. The transformer output is then rectified and filtered through full-wave bridge rectifier CR18 and sent through the passing stage, consisting of Q13 and associated components. It is then applied across the output through current and voltage sensing elements.

This passing stage is the regulating device absorbing the difference between the preregulated dc and the desired or compliance voltages. In voltage regulating operation, the voltage mode section Q7, Q8, Q10 senses the output voltage, develops and amplifies error signal, and feeds this signal through a number of drivers to the passing stages. In current regulating operation, the current mode section (Q3 and Q5) monitors the output current through a sensing resistor (R41) and regulates the voltage developed across the resistor by applying control signals to the drivers and consequently the passing stage. Unregulated supplies provide reverse bias and collector supply voltages to the passing stages and forward bias for the current mode differential amplifiers.

The voltage across the passing stage is sensed by a transistor (Q18) through R66 in the preregulator circuitry, and compared to a reference voltage developed across R62. Any differential voltage across the base emitter junction of Q18 is fed back as an error signal to the input SCR through preregulator amplifier (Q17), pulse generating circuitry (Q16) and pulse transformer T3.

An overvoltage amplifier (Q19, Q21-24) compares the output voltage to an adjustable reference, set by R85. If this reference is exceeded, the amplifier triggers a crowbar, (CR50) which shorts the output of the unit. At the same time, the unit control circuitry is shut off. The unit must be switched off to remove this electronic short circuit.

4.3.1 Reference Supply

The precisely regulated voltage required for output comparison and error signal development is provided by the following: a reference supply (unregulated supply T2, CR1 and CR4), capacitor (C6), an error bridge (R5, R9 and CR5), two double differential amplifiers (Q2), and a low power passing stage (Q1). Resistor

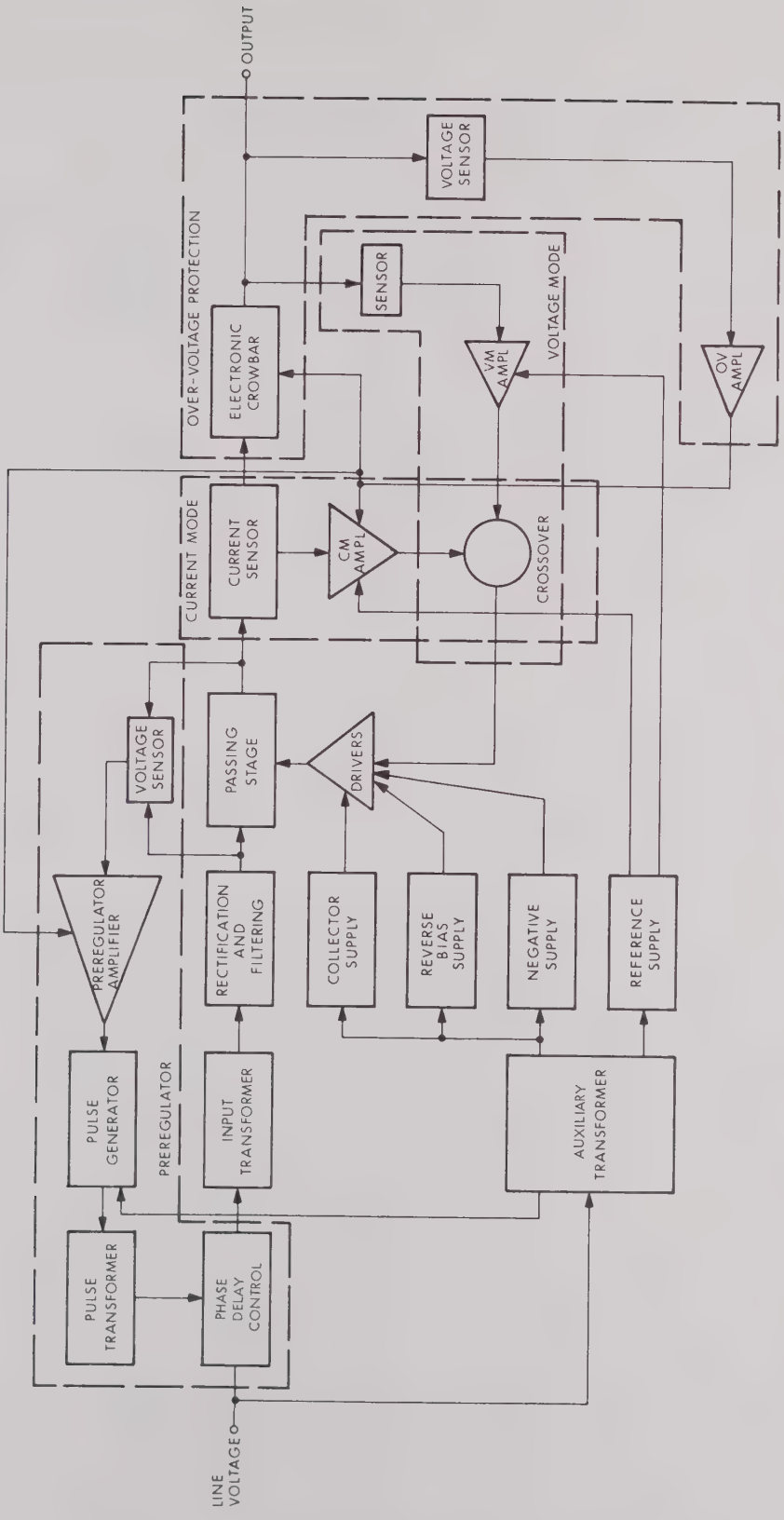


Figure 4-2 SRL System Block Diagram

R2 is a starting resistor, i.e., at turn on it shunts current across the passing stage to allow the reference supply to start functioning.

In general, the supply operates as follows: The precise reference voltage developed by zener diode CR5 is compared with a portion of the output voltage developed across R9. The error signal which develops is amplified first by differential amplifier (Q2-1/2-2) and then by amplifier (Q2-3/2-4). The amplified signal is then applied to the base of Q1, where it alters stage impedance and therefore the absorbed voltage.

As a specific example of circuit operation, assume that, as a result of an imput line change, supply output voltage starts to increase. The voltage across R9 will then increase, and the base of Q2-2 will become more positive with respect to the base of Q2-1. Q2-2 will then conduct more current and Q2-1 less. (Note that the sum of the currents through Q2-1 and Q2-2 is held constant by the zener voltage across R8). With an increase in current, the voltage developed across R7 increases, while that across R6 decreases. The base of Q2-4 will therefore become more negative with respect to the base of Q2-3. As a result, Q2-4 will conduct less current, and the drive on Q1 will diminish. Q1 will increase its absorbed voltage, thereby regulating the output to a precise 8.9 volts.

4.3.2 Voltage Mode Section

The voltage mode section consists basically of two double differential amplifiers (Q10-1, Q10-2, and Q7, Q8), a constant current generator (Q10-3) and sensing string (R21, R53A and B). The section functions to sense unit output voltage, to detect differences between the desired and the actual output voltages, and to convert and amplify these differences into error signals used to control the passing stage (Q13) impedance.

To clarify circuit operation, a specific example is given. Suppose that as a result of a load change the output voltage begins to increase. The increase is sensed across R53A and B, and Q16 base becomes more negative with respect to the base of Q10-2, which is connected to the positive sense terminal TB2-5. Current through Q10-1 decreases while that through Q10-2 increases. (The sum of the Q10 operating currents is fixed by constant current generator Q10-3, R37, CR12 and 13). The decreasing current through R23 lowers its voltage while that across R24 increases. As a result, the base of Q7 becomes less negative with respect to the base of Q8, and the Q7's operating current decreases. This operating current is then the signal current to the drivers and passing stages, and any changes in it are reflected in changes in passing stage impedance and consequently output voltage. A constant current source consisting of Q3-3 and R44 keeps Q7 operating in the high gain region. A decrease in signal current, resulting from an increase in output voltage, increases passing stage impedance to reduce the output to the desired voltage.

Transistor Q9, diode CR10 and resistor R24 form the down programming time circuit. Under normal operating conditions, Q9 is nonconducting due to insufficient base emitter voltage. However, when a programming resistance or voltage signal change is made to lower the output voltage, Q9 goes rapidly into conduction and almost instantaneously shunts the signal current into the sensing string. As a result, no signal is impressed on the drivers and the passing stage impedance increases, absorbing more voltage.

As the bases of Q16 and Q17 regain their equilibrium, Q9 reverts to its nonconducting state, and normal regulation at the programmed voltage takes place.

4.3.3 Power Limiting Circuit

In normal operation the passing stage voltage is kept constant by the preregulator. When the output is shorted, the voltage, and thus the power dissipated by the passing stage will exceed the maximum limits until input capacitor C23 reaches its maximum value. Therefore a power limiting, or protective circuit consisting of Q15, R49 and associated components has been included to limit the current through the passing stage.

Transistor Q15 senses the voltage across R49, as the voltage across the passing stage. In normal operation, the base/emitter junction is reverse biased, and no collector current flows. As the passing stage voltage increases, the base of Q15 becomes more positive with respect to the emitter and turns Q15 on. The collector current then absorbs the current mode reference current from Q6. This lowers the maximum current capable of being delivered by the passing stage, thus limiting the power dissipation.

4.3.4 Current Mode Section

The current mode section serves two functions. In constant voltage operation, it protects the load from excessive currents by limiting action and in constant current operation, it regulates the output current to the desired value. Main components include differential amplifiers R41, switch (Q3-3) and potentiometers (R18A/B). R15 is a calibration resistor used to adjust amplifier Q5-1 and Q5-2 to the zero set point.

Basically, the current section functions as follows: the voltage across sensing resistor R41, developed by the load current, is compared to a fixed reference. This reference is derived from 8.9 V regulated supply and the constant current generator (U1, R17 and Q6). Any error signal which develops is amplified first by Q5-1 and Q5-2, and Q3-1 and Q3-2, and then by Q3-1 and Q3-2. A constant current source composed of Q4, R12, CR6 and CR7 is used to increase the collector impedance of Q3-2 and consequently the gain of this stage. The amplified signal is then applied to the base of switch Q3-3, which then functions as a variable impedance to control the signal from the voltage mode section to the driver and passing stages. It should be noted that the signal from the voltage mode section is at full strength and that, in voltage mode operation, Q3-3 is saturated.

As a specific example of current mode operation, suppose that the load current begins to drop below the setting of the output current adjust, R18A and B. The voltage across R41 decreases, and the base of Q5-1 becomes negative with respect to the base of Q5-2. The operating current through Q5-1 increases and more voltage builds up across R31. The base of Q3-1 becomes more positive with respect to the base of Q3-2. The voltage developed across R10 drops, and the drive on Q3-3 increases. Q3-3's impedance will decrease, and the signal current to the drivers and passing stages will be greater. Consequently, passing stage impedance decreases, and output current increases to the regulator setting.

4.3.5 Drivers and Passing Stages

Basic components in the drivers and passing stages include transistors Q11/14, Q12, and Q13. Driver Q11/14 amplifies the signal produced by either the voltage or current mode sections, and applies to it the base of Q12 for further amplification. The amplified signals are then applied to the passing stage bases where they act to alter the stage impedance, thereby controlling the output voltage or current. R40 assures equal current sharing among the passing stage.

4.3.6 Preregulator

The preregulator section consists of the following: reference transistor Q20, amplifiers Q17 and Q18, pulse generator Q16, and transformer T3. The function of the preregulator is to generate and control the firing pulses for the input SCR, thus controlling the voltage appearing across the passing stage network.

The pulse regulator section consists primarily of reference transistor Q20, capacitor C39, and zener diode CR38. This circuit produces pulses at the secondary of T3 which are synchronized to the zero crossing of the input sinewave voltage of T2 (see Figure 6-7). CR38 maintains a constant voltage to operate the unijunction transistor Q16. When the input sinewave voltage goes to zero at the end of each half cycle, the zener voltage collapses toward zero. Unijunction Q16 fires and resets the voltage across C39, which then recharges through R60 to a pedestal voltage established by the voltage at the collector of amplifier Q17.

Q16 will fire when its firing potential, predetermined at approximately 50% of the voltage across CR38, is reached by C39. A firing pulse is then produced and transmitted to the SCR through T3. The time taken for C39 to charge to the firing potential is controlled by the level of the pedestal voltage, which is a function of the collector current of Q17. The base of Q17 is driven by the error signal of preregulator amplifier Q18. Figure 6-7 depicts typical pulse forming network waveforms as related to the rectified input waveform.

The preregulator amplifier section senses the voltage across the passing stage, and produces an error signal proportional to any increase or decrease in the passing stage voltage. This signal is such that if the voltage increases, the current through Q17 increases, lowering the pedestal voltage, causing the firing angle of the primary SCR to be delayed, and in turn maintaining the passing stage voltage relatively constant.

4.3.7 Overvoltage Protection

This circuit compares the output voltage with a preset reference voltage and activates the electronic "crowbar" CR50 when this limit is exceeded. S2 on the front panel (OVERVOLTAGE SET) provides for monitoring the reference tripping voltage level.

The reference voltage is established by OVERVOLTAGE ADJ potentiometer R85 on the front panel, and appears on the base of Q23, which is half of the Q22/Q23 differential comparator. The power supply output voltage is applied to the base of Q22, whose output is applied to CR50 through SCR diode CR45. When CR45 fires, due to an overvoltage condition, it triggers the crowbar which clamps the output voltage at zero. This activates the OVERVOLTAGE indicator DS2 on the front panel and cuts off the input of the preregulator through Q19 and CR44,

calling for maximum phase delay, thus reducing the dc input voltage. Transistors Q24/Q25 act as a turn-on circuit, which prevents the overvoltage circuitry from triggering during unit turn-on/turn-off.

4.3.8 Reverse Bias Section

The reverse bias section functions during load off transients to improve response time by rapidly cutting off the passing stages and to absorb the thermal effect current generated by high junction temperatures. The section is comprised of an unregulated supply and a number of biasing resistors.

A secondary of transformer T2, rectifiers CR22/CR23 and capacitor C2 form a supply which feeds reverse bias through R45-48 to transistors Q11, Q12, an Q13.

4.3.9 Stabilization

A tendency toward instability under certain operating conditions is inherent in the operation of any high gain feedback amplifier. To preclude unstable operation, SRL power supplies have been equipped with a number of stabilization networks and capacitors. In the voltage mode section, these include networks C30-R54, C15-R20 and capacitors C13, C16 and C43. The current mode section includes network C12-R16, and capacitor C14. Network C9-R3 and capacitor C3 are used in the reference supply, and capacitors C24/C25 stabilize drivers Q12 and Q11/Q14.

4.3.10 Power Section

In the power section, ac line voltage is applied to the primary of T1 through input filter L1, and SCR's CR15/CR16. The input of the secondary is rectified by a full wave bridge rectifier (CR18), and filtered by capacitor C23 before being delivered to the passing stage input.

4.3.11 Thermal Overload Section

The thermal overload section consists of thermostat S3, resistor R95, diode CR57 and indicator DS3, which functions when unit temperature exceeds a predetermined limit. When this limit is reached, thermostat S3 closes, and the voltage across R74 is sufficient to cut off the preregulators, thus blocking the primary SCRs and removing the dc input to the unit.

4.3.12 Collector Supply

In order to limit the voltage across the passing stage, a separate bias supply provides collector bias voltages to the passing stage driver transistors Q11, Q12, and Q14. This supply consists of secondary T2-15, -16 and -17, diodes CR27/CR28, and capacitor C26.

SECTION 5

MAINTENANCE

5.1 GENERAL

This section provides periodic servicing information, troubleshooting data, calibration procedures and performance testing procedures. The troubleshooting data should be used in conjunction with both the schematic diagram (Figure 6-2), which gives voltage check points, and section 4, which outlines the principles of operation. Figure 6-1 physically locates the parts appearing on the schematic. Any questions pertaining to repair should be directed to the nearest service representative, or to the Service Dept., Sorensen Company, 676 Island Pond Road, Manchester, New Hampshire, 03103. Include the model and serial numbers in any correspondence. Should it be necessary to return a unit to the factory for repair, authorization from the Service Department must first be obtained.

5.2 PERIODIC SERVICING

Units in the SRL Series should periodically be removed from service and cleaned. Compressed air should be used to remove dust or other accumulations from around chassis components. Naphtha or an equivalent solvent should be used on painted surfaces. The front panel may be washed with a weak solution of soap and warm water.

5.3 TROUBLESHOOTING

Table 5-2 provides a list of malfunction symptoms along with a tabulation of the possible cause or causes for each symptom. Note that the failure of one component may result in a "chain reaction" effect. For example, if one of the passing stages (Q13) opens, the remaining Q13 (where provided) may become overloaded and subsequently fail. In a like manner, if a diode in one of the full wave rectifiers fails, its complementary rectifier and the main transformer may be damaged.

The data listed in Table 5-2 are based on prototype reliability studies, not on actual solutions to field problems, and therefore may be incomplete. Where the probable cause for a symptom lists a transistor short, it is either a base collector, emitter collector or base emitter collector short. Base emitter shorts may give an entirely different set of symptoms. It is therefore recommended that before a particular section is checked for failures, each transistor within the section be tested for base emitter shorts. (Typical base emitter voltage is approximately 0.6 volt.)

5.4 CALIBRATION

Following repair, the unit should be recalibrated to insure that replacement components have not appreciably altered performance characteristics. When calibrating, follow the sequence outlined in the following paragraphs.

NOTE

If under full load, at high/low line inputs, the dc passing stage voltage (from C23 (+) to positive output terminal) is within ±10% of item A, Table 5-1, further calibration of the unit should not be necessary.

5.4.1 Pre-Test Inspection

Check that links are firmly in place across barriers on terminal board and leads between sensing and output terminals are in place.

5.4.2 Preliminary Adjustments

1. Preregulator

a. On the printed circuit board, turn potentiometers R9 (reference adjust), R15 (current mode zero adjust) and R63 (passing stage voltage set) to midpoint in rotation range; turn R78 (preregulator firing angle control) fully counterclockwise.

b. On the front panel, turn VOLTAGE mode COARSE control (R53A), FINE control (R53B), CURRENT mode COARSE control (R18A), FINE control (R18B) and OVERVOLTAGE SET (R85) fully clockwise.

c. Connect a voltmeter across C11 (reference supply output).

d. With nominal* input voltage applied at 60 Hz and with no load applied, set POWER switch to ON. Pilot light should illuminate.

e. Adjust R9 to obtain 8.9 V across C11.

f. Set POWER switch to OFF, disconnect voltmeter from C11.

g. Connect a voltmeter from positive terminal of C23 to positive output terminal, (hereafter referred to as passing stage voltage). Rotate R78 clockwise. Connect an oscilloscope across terminals 4 and 5 of transformer T3.

h. Set POWER switch to ON. Set input voltage to 125 or 230 Vac (as applicable). Adjust R63 to obtain the passing stage voltage specified in item A of Table 5-1. Adjust output voltage to rated voltage (Item B, Table 5-1) and apply rated load current (Item C, Table 5-1).

Decrease R78 so that the output voltage decreases to approximately 50% of the rated output. Observe waveform on the oscilloscope. It should be similar to that in Figure 5-1. Gradually decrease the input line voltage with variable control while also increasing the output voltage by means of R78. Continue this procedure until time "t" reaches a minimum of 0.5 ± 0.2 milliseconds. The output voltage should now be equal to the rated output. Vary the input line voltage and check that "t" is at a minimum null. If "t" is not at a minimum null, readjust

R78 at the line voltage where "t" is at a minimum null. This line voltage should be no higher than approximately 105 Vac (190 Vac for nominal 210 Vac input models). Check the waveform across T3 terminals 7 and 8. It should be similar to that across terminals 4 and 5.

*Nominal: 115, 210 or 230 Vac as applicable.

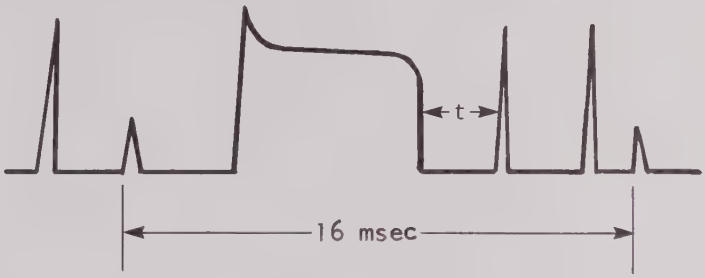


Figure 5-1 T3 Scope Display

Set line voltage to 125 Vac (or 230 Vac for the 190-230 input models) and check passing stage voltage Item A in Table 5-1. Set POWER switch to OFF. Apply locking compound to R63 and R78. Remove oscilloscope from transformer T3 and voltmeter from C23 (+) to positive output.

2. Voltage Mode Calibration

   a. At the rear terminal board (mounted on the printed circuit board) remove link between terminals 3 and 4 and connect a precision resistance exactly the value specified under Item D in Table 5-1. Assure that the leads are firmly connected both at terminal board and the resistance.

   b. Connect a digital voltmeter across rear output sense terminals.

   c. With nominal input voltage at 60 Hz applied to input, set POWER switch to ON.

   d. Adjust R9 to obtain output voltage specified under Item B, Table 5-1. Apply locking compound to R9.

Table 5-1, Difference Data

Item	20-12	40-6	60-4	10-25	20-25	40-12	60-8
A (V dc)	8.9±0.1	11.4±0.1	14.5±0.1	4.8±0.1	6.6±0.1	12.5±0.1	14.6±0.1
B (V dc)	20±0.07	40±0.14	60±0.21	10±0.035	20±0.07	40±0.14	60±0.21
C (A dc)	12	6	4	25	25	12	8
D (ohms)	4000	8000	12,000	2000	4000	8000	12,000
E (mA)	±10	±5	±5	±20	±20	±10	±5
Item	40-50	40-25	60-17	10-100	20-50	40-50	60-35
A (V dc)	5.4±0.1	9.9±0.1	13.7±0.1	5.4±0.1	7.0±0.1	8.5±0.1	13.4±0.±
B (V dc)	10±0.035	40±0.14	60±0.21	10±0.035	20±0.07	40±0.14	60±0.21
C (A dc)	50	25	17	100	50	50	35
D (ohms)	2000	8000	12,000	2000	4000	8000	12,000
E (mA)	±50	±25	±15	±100	±50	±50	±20

3. Current Mode Calibration

   a. Rotate COARSE and FINE CURRENT controls fully counterclockwise. Set POWER switch to OFF. Connect appropriate ammeter in series with the load, to set output current to zero.

   b. Set POWER switch to ON, and adjust R15 to obtain current between zero and that specified under Item E, Table 5-1. Apply locking compound to R15. Set POWER switch to OFF. Remove ammeter.

5.5 PERFORMANCE TEST

Sensitive instruments such as the SRL series require rigorous testing methods if a true evaluation of performance is to be made. Wherever possible, twisted leads should be used with test equipment to reduce stray pickup. At the power supply terminal board, these leads must be firmly screwed to the terminals. Alligator clips and similar types of connectors are not suitable. Note that the output specifications are applicable at rear terminals only. (Front panel binding posts may introduce errors which, although small, are sufficient to adversely influence measurements.) In addition, grounding techniques in which more than one device in the test system is grounded (excluding AC inputs) may introduce ripple through ground loops. Although unrelated to supply output, this ripple will be displayed on the test oscilloscope.

5.5.1 Voltage Mode Regulation

To check voltage mode regulation, connect test system as shown in Figure 5-2. For regulation testing, the oscilloscope and RMS voltmeter are not required. Use a variable autotransformer for ac input, connect an ac voltmeter across transformer output terminals and proceed as follows:

1. At no load, adjust output to maximum rated voltage at nominal ac line voltage and record dc DVM reading.
2. Decrease ac input line voltage by 10%. Record dc DVM reading. Increase ac input line voltage to 10% above nominal and again record dc DVM reading.
3. With nominal ac input voltage applied, load the unit until the dc ammeter indicates the 55°C rated output current. Record the dc DVM reading.
4. Decrease the ac line input by 10% and record the dc DVM reading. Increase the ac line input to 10% above nominal and record the dc DVM reading.
5. The total deviation (maximum DVM reading minus the minimum DVM reading) should not exceed the limits set in Table 1-3 or 1-4.

5.5.2 Voltage Mode PARD*

To check a periodic and random deviations in the voltage mode, connect a true RMS voltmeter and oscilloscope across unit sense terminals as shown in Figure 5-2. RMS voltmeter should have a 7MHz bandwidth and bandwidth of oscilloscope should be at least 25 MHz. Proceed as follows:

1. Apply nominal input voltage.
2. At no load, adjust unit output voltage to maximum rated.
3. Apply load until dc ammeter indicates rated output current at 55°C.
4. Observe oscilloscope and voltmeter. Maximum RMS and peak voltages should not exceed the specifications as noted in Tables 1-3 and 1-4.

*Periodic deviation in output voltage from its average value.

5.5.3 Current Mode Regulation

This test consists of measuring the voltage drop deviation resulting from a full line swing and a full load change across a shunt resistor. Set up test equipment as shown in Figure 5-3. If possible, select a precision (± 1%) shunt which will provide a voltage drop of approximately 0.5 volt at unit maximum rated current.* Also, to reduce temperature coefficient effects, the shunt selected should be capable of dissipating twice the maximum power output attainable. The load must be able to absorb the full compliance voltage. For regulation testing, the true RMS voltmeter and oscilloscope are not required. Proceed as follows:

*A standard instrument style 100 mV shunt may be substituted.

1. At no load and nominal ac line input voltage, rotate VOLTAGE controls fully clockwise. Note the output indicated on the DVM. This must be at least 1% above the rated maximum voltage.

2. Set CURRENT controls to obtain the 55°C rated output current into a short circuit (close load switch).

3. Apply load until output drops to exactly the maximum rated compliance voltage (equal to rated maximum output volts rating).

4. Record DVM reading (use 4 places if possible).

5. Repeat steps 1, 2, 3, and 4 at ±10% ac nominal line.

6. At nominal ac line input, close load shorting switch and record dc DVM reading.

7. Repeat step 6 at ±10% nominal line voltage.

The total of the deviations obtained should be no greater than that specified in Table 1-3 or 1-4.

NOTE

Convert shunt mV readings to mA by using the shunt constant (i.e., using 100 mV, 25A shunt: 1 mV equals 250 mA).

5.5.4 Current Mode PARD

To check current mode periodic and random deviations, connect a true RMS voltmeter and an oscilloscope across shunt as shown in Figure 5-3. The DVM is not required. Proceed as follows:

1. Set up for maximum compliance voltage per para. 5.5.3, steps 1, 2, and 3.

2. Set input ac line voltage to 10% above nominal.

3. Observe RMS voltmeter and oscilloscope. Maximum allowable RMS current should not be greater than that specified in Table 1-3 or 1-4.

NOTE

Convert shunt mV readings to mA by using the shunt constant (i.e., using 100 mV 25A shunt: 1 mV equals 250 mA).

5.5.5 Drift

The drift in both voltage and current modes is measured using a strip chart recorder at constant load, line and ambient temperature. Allow one half hour for

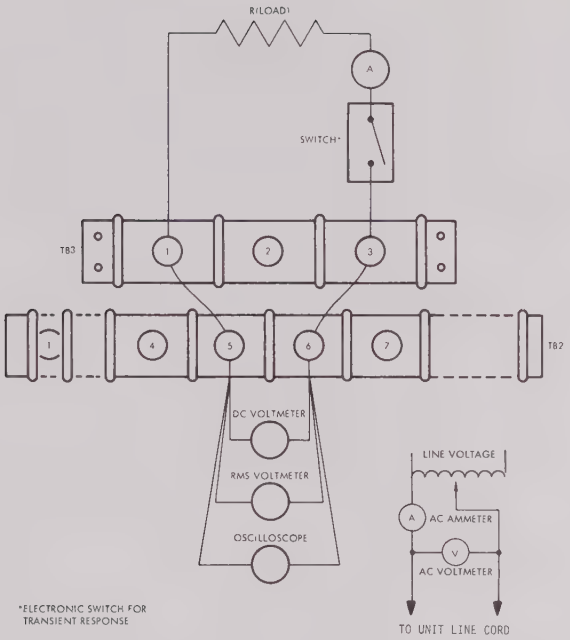


Figure 5-2 Voltage Mode Performance Test Setup

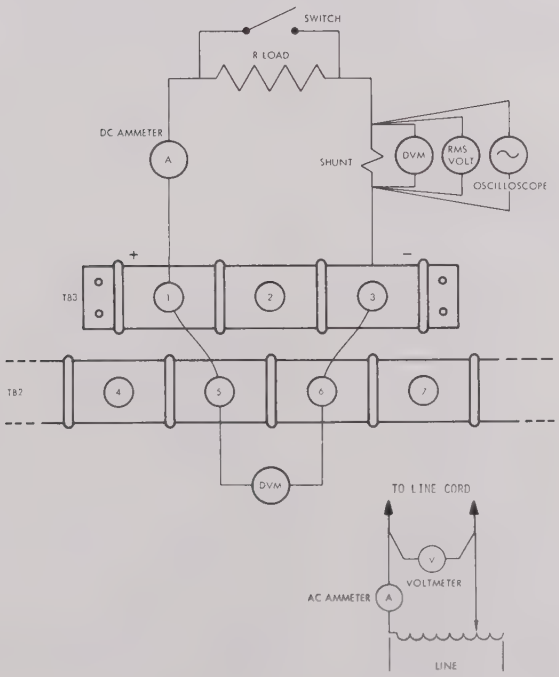


Figure 5-3 Current Mode Performance Test Setup

voltage mode warmup and a full hour for current mode warmup. Drift specifications are listed in Tables 1-3 and 1-4.

5.6 HI-POT TEST PROCEDURE

High potential test procedures have been carefully carried out at the factory. These units are 100% tested and should not require further testing in the field.

High potential tests can overstress or destroy the power semiconductors in this power supply if improperly applied.

Isolation measurements may be made using a standard VOM (Simpson 260 or equivalent) on the highest resistance scale available.

If it is essential to use the high potential test method, please contact the factory for information on special precautions that should be taken.

CAUTION

Sorensen Company cannot be held liable for any malfunctions resulting from the application of a high potential test (greater than 100V). See standard Sorensen Company warranty.

Table 5-2 SRL Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE	REMEDY
I No Output, Pilot light does not glow	Internal Fuse (F2)	Replace F2
II Low or No Output-Voltage Mode	A. Overvoltage circuitry	1. Check that DS2 (OVERVOLTAGE) on front panel is not illuminated 2. Set S2 to overvoltage set position and read level on meter. Adjust R85 (OV ADJ on front panel) to its maximum level. Switch unit off, and on again after a few moments. If problem does not disappear, determine if output current adjust (R18) functions properly. If so, check for CR50 short. If R18 does not function, check for CR45 short, or defective Q22-Q25.
	B. No pre-regulator output (no voltage across Q23).	1. Check for presence of firing pulses at T3-4 and -5, or T3-7 and -8 (See Figure 6-7). If pulse is present, SCR CR 15, or 16 defective. 2. If no pulse at T3, check signal across CR38 (Figure 6-7). If proper signal exists, check for defective transistors Q16 or Q17. 3. If CR38 signal is not correct check CR38, CR35 or CR36.
	C. 4.7-volt supply	Check for 4.7 volts across CR29. If incorrect, check CR29 or R28.
	D. 9-volt supply	Check for proper voltage across C11. If incorrect adjust using R9. If no effect, defective Q1 or IC Q2.
	E. Current Mode section	Short Q3-3. If output voltage exists, check for defective Q5, Q3-1, Q3-2 or Q4.
	F. Voltage Mode section	Short Q3-3. If no output voltage, check bias across CR11. If forward-biased check Q7, Q8 and check for shorted Q3-4. If reverse-biased, replace Q10 and check for shorted Q3-4.

Table 5-2 SRL Troubleshooting Chart (Cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
II Low or No Output, Voltage Mode (continued)	G. Drivers or Passing Stage	Check for open Q11-Q14.
III High Output, Voltage Mode	A. Reference supply	Output should be ripple-free at 8.9 Vdc. If adjustment with R9 is to no avail, check for shorted Q1, or defective Q2.
	B. Drivers or Passing Stage	Short TB2-9 to TB2-5. If no change, check for shorted Q11-Q14. If problem disappears, check for open Q3-4, Q8, or defective Q10 or shorted Q7. Check for presence of 4.7 volts across CR29.
IV Low Output,	Current Mode Section	1. Check for 2.1 volts across R17. If not, check U1 and Q6. 2. Place short across Q3-3. If no change, check for opne Q7. 3. Check for Q15 leakage or shorted or defective associated components. 4. Check for defective Q5 or Q3.
V High Output, Current Mode	Current Mode Section	1. Same as IV-1. above. 2. Check for shorted Q3-3 or defective Q5 or Q3.
VI Repeated shutdown of unit due to themostat operation.	Excessive voltage across C23, due to: A. Pre-regulator B. Passing Stage C. Fan Inoperative	CR15/CR16 SCR Shorted components, Check Q11-Q14. Check fan motor or restriction of fan blade.

SECTION 6

DRAWINGS AND PARTS LISTS

6.1 GENERAL

This section contains all the drawings referenced throughout the text. Included are the system schematic diagram, a typical printed circuit board showing component layout, typical chassis assembly photographs with major components identified, and typical impedance and crossover characteristic curves.

This section also includes the replaceable parts lists. All parts are identified by circuit symbol, keyed to the schematic diagram. Included are part descriptions, and Sorensen part number. Values for components required with 210/230 volt inputs (M1/M2 options) are detailed.

6.2 ORDERING PARTS

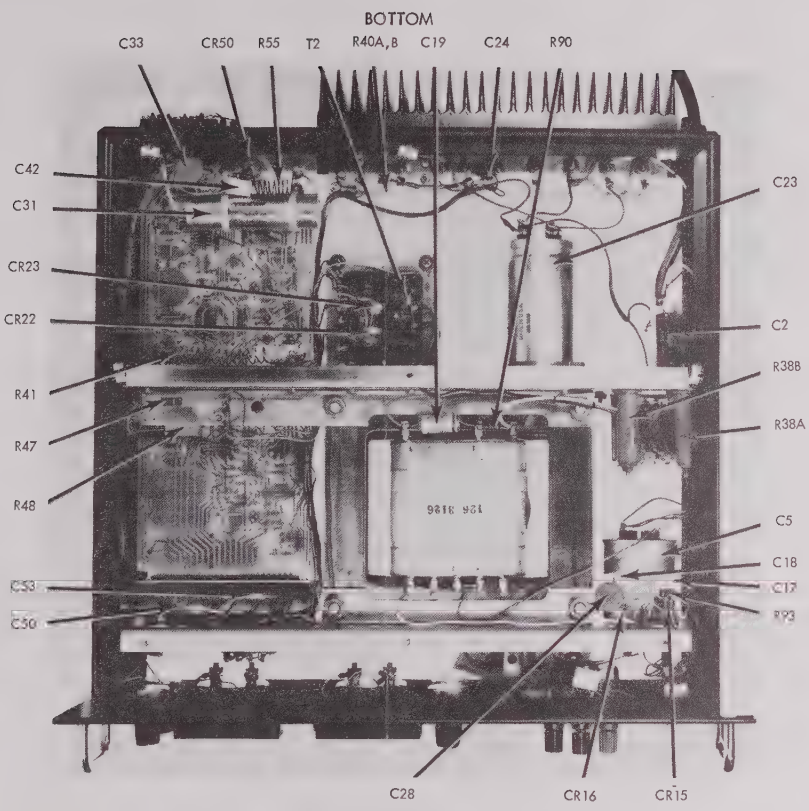
When ordering parts from Sorensen Company, include the Sorensen part number and the unit model number. Call (603) 668-4500, or address order to:

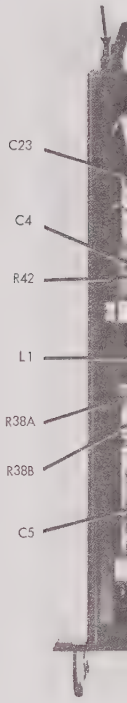
Sorensen Company
Replacement Parts Dept.
676 Island Pond Road
Manchester, N.H. 03103

Table 5-2 SRL Troubleshooting Chart (Cont'd)

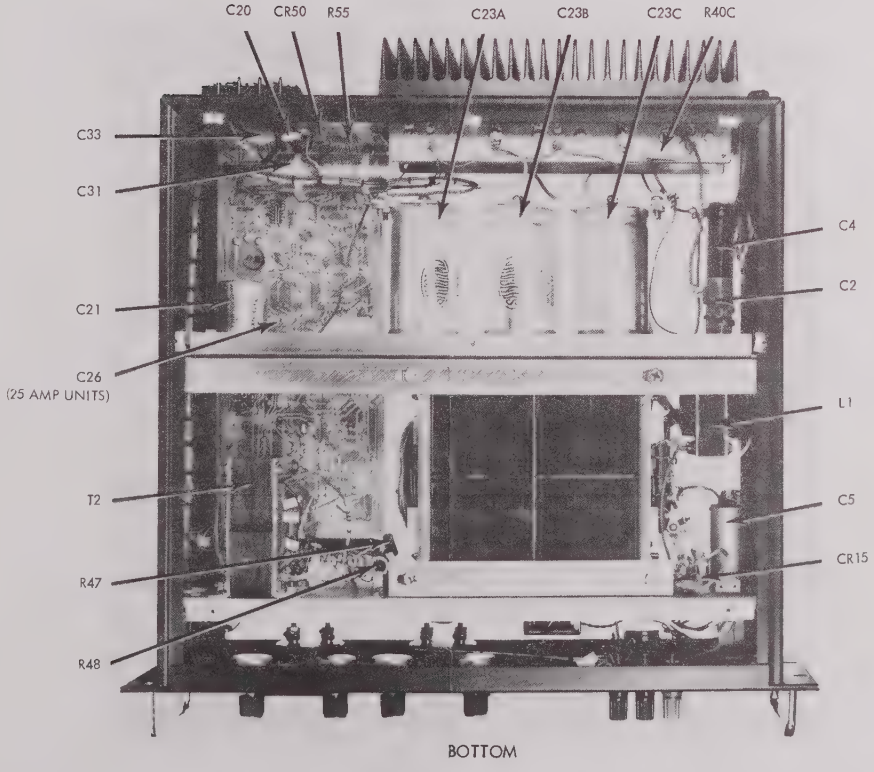
SYMPTOM	PROBABLE CAUSE	REMEDY
II Low or No Output, Voltage Mode (continued)	G. Drivers or Passing Stage	Check for open Q11-Q14.
III High Output, Voltage Mode	A. Reference supply	Output should be ripple-free at 8.9 Vdc. If adjustment with R9 is to no avail, check for shorted Q1, or defective Q2.
	B. Drivers or Passing Stage	Short TB2-9 to TB2-5. If no change, check for shorted Q11-Q14. If problem disappears, check for open Q3-4, Q8, or defective Q10 or shorted Q7. Check for presence of 4.7 volts across CR29.
IV Low Output,	Current Mode Section	1. Check for 2.1 volts across R17. If not, check U1 and Q6. 2. Place short across Q3-3. If no change, check for opne Q7. 3. Check for Q15 leakage or shorted or defective associated components. 4. Check for defective Q5 or Q3.
V High Output, Current Mode	Current Mode Section	1. Same as IV-1. above. 2. Check for shorted Q3-3 or defective Q5 or Q3.
VI Repeated shutdown of unit due to themostat operation.	Excessive voltage across C23, due to: A. Pre-regulator B. Passing Stage C. Fan Inoperative	 CR15/CR16 SCR Shorted components, Check Q11-Q14. Check fan motor or restriction of fan blade.

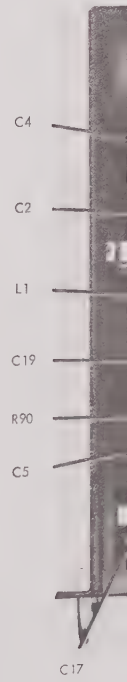
UNITS 20-12, 40-6, 60-8, 60-4 (SHOWN)

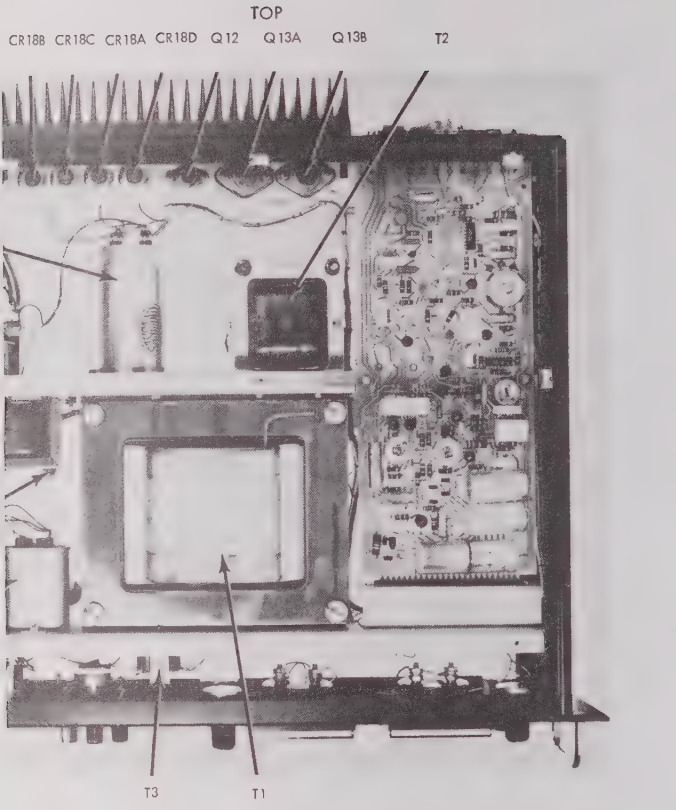




UNITS 10-25, 20-25, 40-12 (SHOWN)







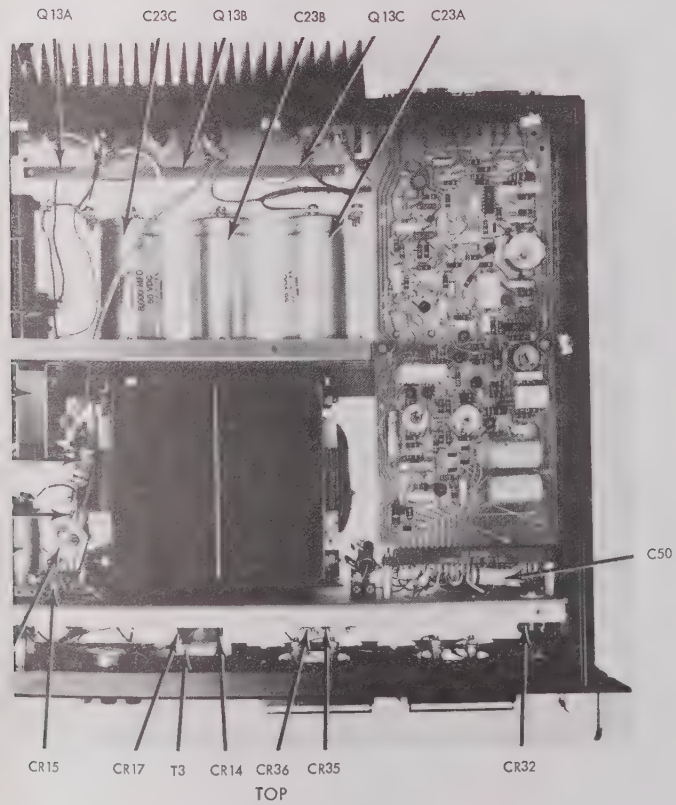
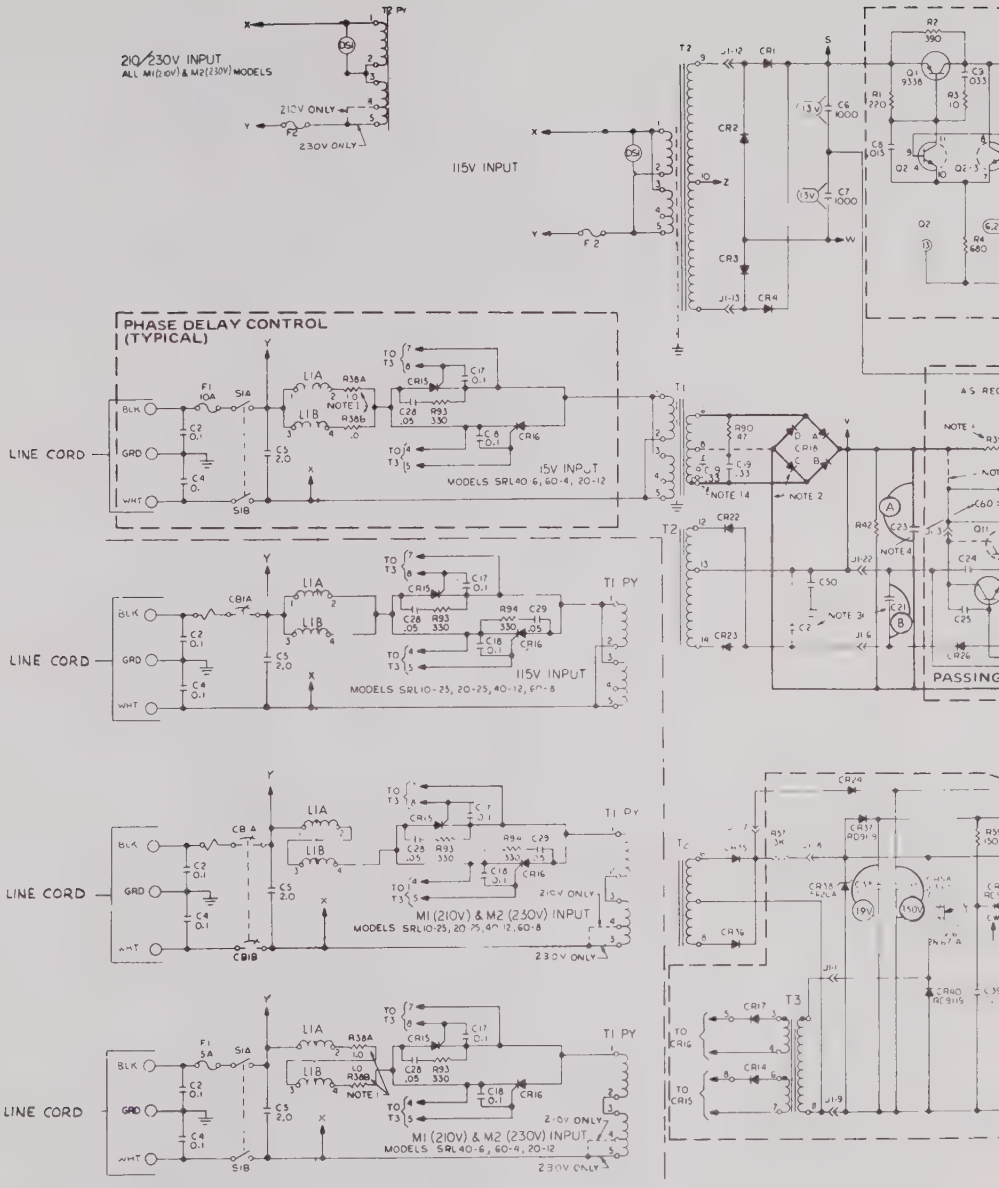


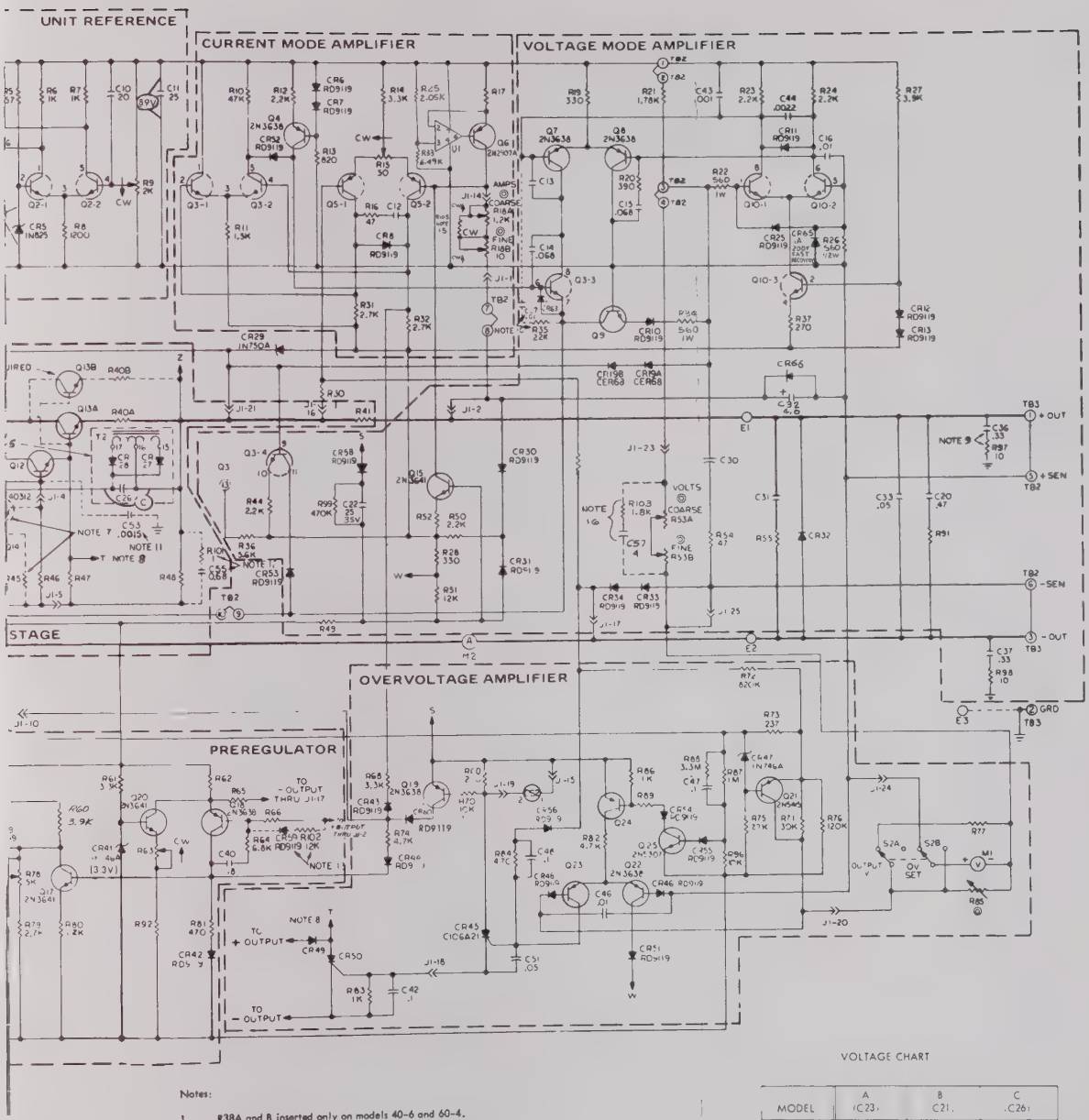
Figure 6-1 Typical Chassis Assemblies
SRL Convection Cooled Units



* SELECTED FOR VOLTAGE BREAKDOWN CHARACTERISTICS

UNIT	C12	C 13	C 21	C 23	C60	C 24	C 25	C 26	C 30	C 31	C 50	Q 9	Q12	Q13	Q14	Q23	Q
10-25	.1	.01	6.8K	4 X 69K	—	.047	.001	9.6K	.01	3.5K	.15	2N 697	2N 3055	2N 3771 (3)	2N 697	2N 3638	2N
20-12	.1	.01	1.5K	2 X 20K	—	.01	.0033	—	.0022	1K	.10	2N 697	2N 3055	2N 3055 (2)	2N 697	9338	93
20-25	.1	.01	6.8K	5 X 21K	—	.01	.001	9.6K	.015	3.5K	.15	2N 697	2N 3055	2N 3055 (4)	2N 697	9388	93
40-6	.1	.0022	800	14K	.01	.001	.0033	—	.0015	1.1K	.10	2N 697*	40312	2N 3055 (2)*	2N 3019	RCA62490	RC
40-12	.1	.01	1K	3 X 8K	.01	.001	.0033	—	.0022	1.5K	.15	2N 697*	40312	2N 3055 (3)*	2N 3019	RCA62490	RC
60-4	.1	.0022	800	6.5K	.01	.001	.0033	—	.001	1K	.047	40321	40313	2N 3442 (2)	40321	RCA62490	RC
60-8	.1	.0022	1K	2 X 6.5K	.01	.001	.0033	—	.01	1.5K	.15	40321	40313	2N 3442 (3)	40321	RCA62490	RC

UNIT	R 39	R 40	R 41	R 42	R 45	R 46	R 47	R 48	R 49	R 52	R 53A	R 53B	R 55	R 62	R 63	R 65	R 66	R 77	R 85	R
10-25	0	.1(3)	.020	15	1.2K	1.2K	270	5	18K	10K	2K	20	.055	330	1K	4.7K	5.6K	12.1K	3K	27
20-12	.15	.18(2)	.080	50	2.2K	2.2K	470	25	33K	4.7K	4K	40	.4	680	500	12K	10K	24.9K	4K	22
20-25	0	.18(4)	.020	25	1.2K	1.2K	220	4	33K	10K	4K	40	.055	680	1K	12K	10K	24.9K	4K	22
40-6	0	.27(2)	.150	150	—	2.2K	680	50	47K	4.7K	8K	80	.4	820	500	22K	18K	49.9K	8K	18
40-12	.1	.18(3)	.080	75	—	2.2K	470	25	47K	4.7K	8K	80	.44	820	500	22K	18K	49.9K	8K	18
60-4	0	.39(2)	.250	400	—	2.2K	680	75	47K	4.7K	12K	120	.4	1K	500	33K	27K	80.6K	12K	15
60-8	0	.39(3)	.125	200	—	2.2K	390	35	47K	4.7K	12K	120	.24	1K	500	33K	27K	80.6K	12K	15



Notes:

1. R38A and B inserted only on models 40-6 and 60-4.
2. CR18C and D not used on 10-25, and indicated lead is wired to T 1-8.
3. C21 relocated to dotted position except Models 20-12, 40-6 and 60-4.
4. C60 used only on models 40-12, 60-8, 40-6 and 60-4.
5. Bias supply CR27, CR28 and C26 not used on 20-12, 40-6, 40-12, 60-4 and 60-8 in which case referenced dotted connection is used.
6. R39 inserted only on 20-12 and 40-12.
7. Q11 and R45 not used on 40-6, 40-12, 60-4, 60-8 (add connection between Q14E and J 1-4)
8. CR49 inserted and indicated lead "T" used only on 60-8.
9. C36 and R97 omitted on 20-12, 40-6 and 60-4.
10. C27 and R35 not used in 40-6, 60-4, and 60-8.
11. C53 used only on 20-12, 40-6 and 60-4.
12. C55 and R101 used only on 20-25.
13. CR59 and R102 used only on 60-4 and 60-8.
14. C19 relocated to dotted position on Model 20-25.
15. R105 MAY BE OMITTED IN SOME UNITS, AS DETERMINED BY TEST LIMITS
16. C57 AND R103 USED ONLY ON MODELS 20-25 AND 60-8.

	R 17	R 29
3638	4.32K	604K
8	2.15K	316K
8	4.32K	1.21M
62490	2.15K	332K
62490	2.15K	634K
62490	2.15K	316K
62490	2.15K	634K

	R 91	R 92	R105
	.24	150	11K
	1	100	7.87K
	.24	100	11K
	1	100	5.62K
	.24	100	7.87K
	1	100	11K
	.24	100	11K

UNIT	F2 115V	F2 210V	F2 230V
10-25	1.5A	1A	1A
20-12	1A	1/2A	1/2A
20-25	1.5A	1A	1A
40-6	1A	1/2A	1/2A
40-12	1A	1/2A	1/2A
60-4	1A	1/2A	1/2A
60-8	1A	1/2A	1/2A

VOLTAGE CHART

MODEL	A (C23)	B (C21)	C (C26)
10-25	14.8	14	11
20-12	28.9	27	Not Used
20-25	26.6	14	11
40-6	51.4	27	Not Used
40-12	52.5	27	Not Used
60-4	74.5	27	Not Used
60-8	74.6	27	Not Used

Figure 6-2 SRL Convection Cooled Units Schematic Diagram

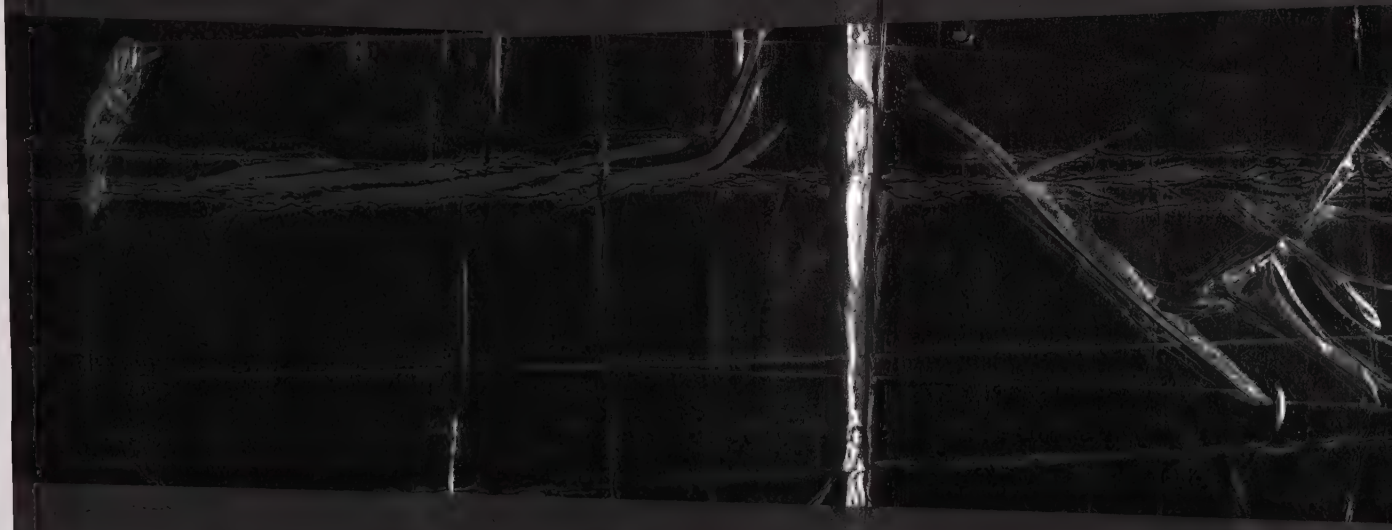


Table 6-1
Replaceable Parts List
Main Assembly
SRL Convection Cooled Units

CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Capacitors (uF unless noted)	
C1	x	x	x	x	x	x	x	Not Used	
C2	x	x	x	x	x	x	x	0.1, 600V	166374-7
C3	x	x	x	x	x	x		Not Used	
C4	x	x	x	x	x	x	x	0.1, 600V	166374-7
C5	x	x	x	x	x	x	x	2, 330 VAC	24-369
C17	x	x	x	x	x	x	x	0.1, 250V	587626-65
C18	x	x	x	x	x	x	x	0.1, 250V	587626-65
C19	x	x	x	x	x	x	x	0.33, 200V	24-2409-16
C20	x	x	x	x	x	x	x	0.47, 250V	587626-69
C21	x		x					6,800, 20V	24-2459-1
		x		x		x		1,500, 40V	24-2453-1
					x		x	1,000, 40V	24-2460-4
C23	x							69,000, 15V (4 Required)	24-2594-1
		x						20,000, 30V (2 Required)	24-2444-6
			x					21,000, 40V (5 Required)	24-2582-2
				x				14,000, 75V	24-1034-4
					x			8,000, 60V (3 Required)	24-2596-1
						x		6,500, 75V	24-2593-1
							x	6,500, 75V (2 Required)	24-2593-1
C26	x		x					9,600, 15V	24-2454-8
		x		x	x	x	x	Not Used	
C28	x	x	x	x	x	x	x	0.05, 600V	24-2010
C29	x		x		x		x	0.05, 600V	24-2010
		x		x		x		Not Used	
C31	x							3,500, 15V	24-2441-5
		x						1,000, 25V	24-2452-4
			x					3,500, 20V	24-2455-3
				x				1,100, 40V	24-2453-4
					x			1,500, 40V	24-2453-1
						x		1,000, 75V	24-2557-5
							x	1,500, 75V	24-2557-4
C33	x	x	x	x	x	x	x	0.05, 600V	24-2010
C36	x		x		x		x	0.33, 250V	587626-68
		x		x		x		Not Used	
C37	x	x	x	x	x	x	x	0.33, 250V	587626-68
C42	x	x	x	x	x	x	x	0.1, 250V	587626-65
C50	x		x		x		x	0.15, 400V	24-2411-14
		x		x				0.1, 400V	24-2411-13
						x		0.047, 400V	24-2411-11
C53	x		x		x		x	Not Used	
		x		x		x		0.0015, 200V	24-2409-2
C55	x	x		x	x	x	x	Not Used	
			x					0.68, 200V	24-2409-18
C57	x	x		x	x	x		Not Used	
			x				x	4, 150V	24-2288-1
C60	x	x	x					Not Used	
				x	x	x	x	0.01, 200V	24-2409-7
CB1**	x							Circuit Breaker, 10A, 250V	92-377
		x		x		x		Not Used	
			x		x		x	Circuit Breaker, 18A, 250V	92-378
								Diodes	
CR14	x	x	x	x	x	x	x	S11	587565-1
CR15**	x	x	x		x		x	C230CX7	26-178-5
				x		x		C220CX245	26-1158-5
CR16**	x	x	x		x		x	C230CX7	26-178-5
				x		x		C220CX245	26-1158-5

*Includes all components not on PCB.
**115V input only. For 210/230V input, see page 6-21).

Table 6-1 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Convection Cooled Units

CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Diodes (cont'd)	
CR17	x	x	x	x	x	x	x	S11	587565-1
CR18A	x	x	x					1N1184A	587382-2
				x		x	x	1N1202A	587393-2
					x			1N1186A	587382-3
CR18B	x	x	x					1N1184A	587382-2
				x		x	x	1N1202A	587393-2
					x			1N1186A	587382-3
CR18C	x		x					Not Used	
		x						1N1184A	587382-2
				x		x	x	1N1202A	587393-2
					x			1N1186A	587382-3
CR18D	x		x					Not Used	
		x						1N1184A	587382-2
				x		x	x	1N1202A	587393-2
					x			1N1186A	587382-3
CR22	x		x					Not Used	
		x		x	x	x	x	S11	587565-1
CR23	x		x					Not Used	
		x		x	x	x	x	S11	587565-1
CR27	x		x					3S11	587566-1
		x		x	x	x	x	Not Used	
CR28	x		x					3S11	587566-1
		x		x	x	x	x	Not Used	
CR32	x	x	x		x			1N1184A	587382-2
				x		x	x	1N1200A	587393-1
CR35	x	x	x	x	x	x	x	S16	587565-4
CR36	x	x	x	x	x	x	x	S16	587565-4
CR49	x	x	x	x	x	x		Not Used	
							x	1N1200A	587393-1
CR50	x							C230UX7	26-178-1
		x	x					C230FX7	26-178-2
				x	x	x	x	C230AX7	26-178-3
DS1	x	x	x	x	x	x	x	Indicator Light	43-357
DS2	x	x	x	x	x	x	x	Indicator Light	43-358
								Fuses	
F1*	x		x		x		x	Not Used	
		x		x		x		10A, 250V	42-1809
XF1		x		x		x		Fuseholder	42-459
F2*	x		x					1.5A, 250V	226-7176P41
		x		x	x	x	x	1.0A, 250V	226-7176P39
XF2	x	x	x	x	x	x	x	Fuseholder	343-1011P2
L1	x	x		x		x		RFI Choke	127-1844
			x		x		x	RFI Choke	127-1849
								Meters	
M1	x							Voltmeter, 0-12V	94-579-1
		x	x					Voltmeter, 0-25V	94-579-2
				x	x			Voltmeter, 0-50V	94-579-3
						x	x	Voltmeter, 0-80V	94-579-4
M2	x		x					Ammeter, 0-30A	94-462-6
		x			x			Ammeter, 0-15A	94-462-4
				x				Ammeter, 0-8A	94-462-2
						x		Ammeter, 0-5A	94-462-1
							x	Ammeter, 0-10A	94-462-3

*115V input only. For 210/230V input, see page 6-21.

Table 6-1 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Convection Cooled Units

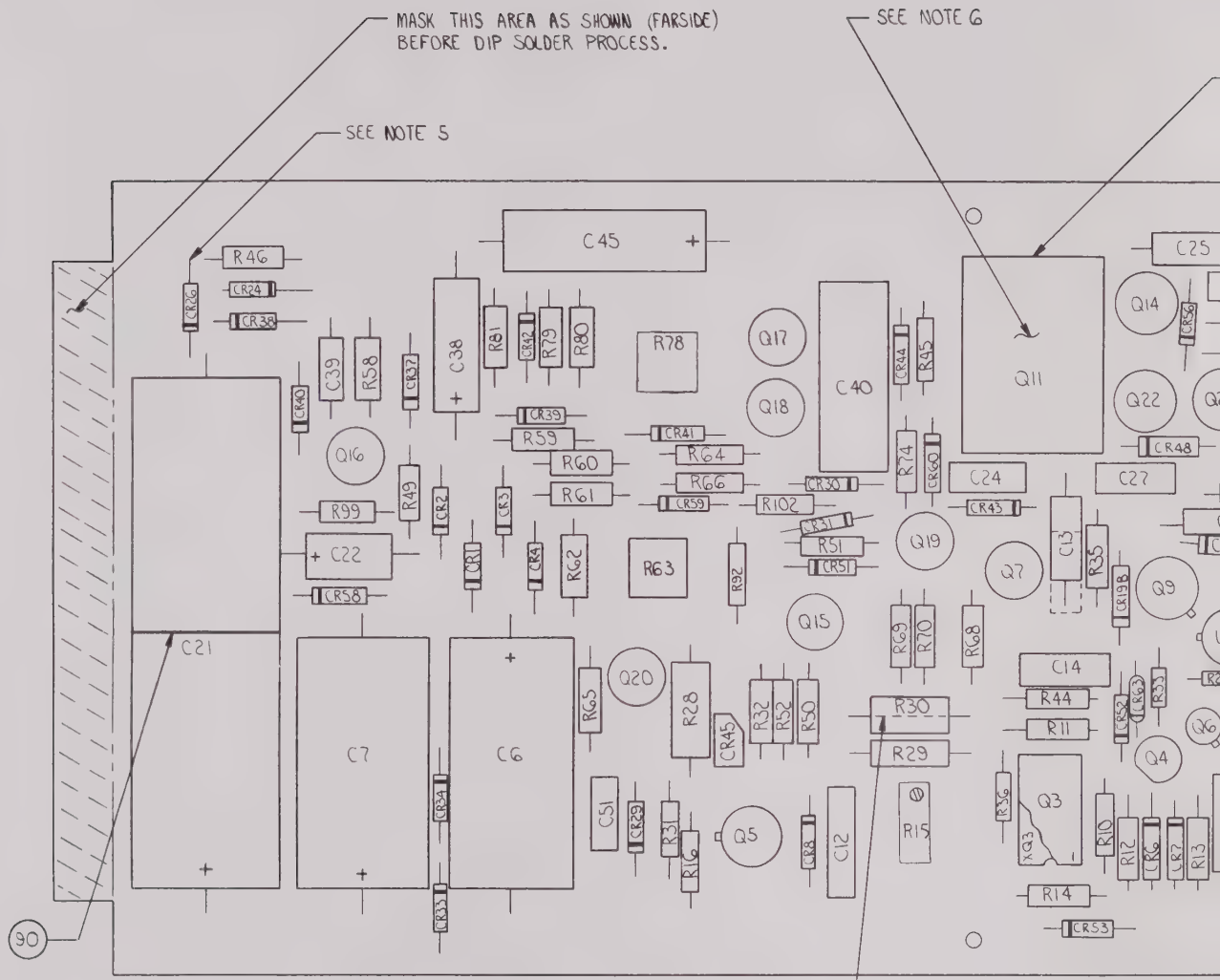
CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Transistors	
Q12	x	x	x					2N3055A	18-151
				x	x			40312 (Selected)	18-177-1
						x	x	40313	18-164
Q13A-D	x							2N3771 (3 Required)	18-202
		x						2N3055 (2 Required)	18-151
			x					2N3055 (4 Required)	18-151
				x				2N3055A (Selected - 2 Req'd)	18-178-1
					x			2N3055A (Selected - 3 Req'd)	18-178-1
						x		2N3442 (2 Required)	18-163
							x	2N3442 (3 Required)	18-163
								Resistors (ohms, 1/2W, ±10% unless noted)	
R18A	x	x	x	x	x	x	x	1.2K, 2W, Variable	29-596
R18B	x	x	x	x	x	x	x	10, 2W, Variable	29-595
R38A/B	x	x	x		x		x	Not Used	
				x		x		1,20W	27-655
R39	x		x	x		x	x	Not Used	
		x						0.15, 30W	27-1535
					x			0.1, 25W	27-775
R40A-D	x							0.1, 12.5W (3 Required)	27-590-1
		x						0.18, 12.5W (2 Required)	27-590-1
			x					0.18, 12.5W (4 Required)	27-590-1
				x				0.27, 5W (2 Required)	586054-6
					x			0.18, 7W (3 Required)	167402-39
						x		0.39, 5W, 5% (2 Required)	167402-38
							x	0.39, 5W, 5% (3 Required)	167402-38
R41	x		x					0.02	190-4125-1
		x						0.08	190-4143
				x				0.15	190-4145
					x			0.08	190-4125-2
						x		0.25	190-4142
							x	0.125	190-4125-3
R42	x							15, 25W	27-744
		x						50, 25W	27-708
			x					25, 50W	27-809
				x				150, 25W	27-767
					x			75, 50W	27-842
						x		400, 25W	27-717
							x	200, 50W	27-843
R47	x							270, 1W	280-1180P53
		x			x			470, 2W	280-1147P62
			x					220, 1W	280-1180P50
				x				680, 2W	280-1147P68
						x		680, 1W	280-1180P68
							x	390, 2W	280-1147P59
R48	x							5, 20W	27-656
		x			x			25, 20W	27-610
			x					4, 25W	27-747
				x				50, 10W	27-599-3
						x		75, 5W	27-452
							x	35, 10W	27-563
R53A	x							2K, 2W, Var., +20, -0%	29-587
		x	x					4K, 2W, Var., +20, -0%	29-588
				x	x			8K, 2W, Var., +20, -0%	29-589
						x	x	12K, 2W, Var., +20, -0%	29-590
R53B	x							20, 2W, Variable	29-591
		x	x					40, 2W, Variable	29-592

Table 6-1 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Convection Cooled Units

CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-6	DESCRIPTION	SORENSEN PART NUMBER
								Resistors (ohms, 1/2W, ±10% unless noted)	
R53B			x	x				80, 2W, Variable	29-593
					x	x		120, 2W, Variable	29-594
R55	x		x					0.055	190-4126
		x		x		x		0.4	190-4144
				x				0.44	190-4127
							x	0.24	190-4164
R57	x	x	x	x	x	x	x	3K, 7W	27-471-9
R77	x							12.1K, 1%	28-1408
		x	x					24.9K, 1%	28-1261
				x	x			49.9K, 1%	28-1409
						x	x	80.6K, 1%	28-1351
R85	x							3K, 2W, Variable	29-597
		x	x					4K, 2W, Variable	29-598
				x	x			8K, 2W, Variable	29-599
						x	x	12K, 2W, Variable	29-600
R90	x	x	x	x	x	x	x	47	280-1145P26
R91	x		x		x		x	0.24, 2W	28-1252
		x		x		x		1, 2W	28-1253
R93	x	x	x	x	x	x	x	330	280-1145P56
R94	x		x		x		x	330	280-1145P56
		x		x		x		Not Used	
R97	x		x		x		x	10	280-1145P2
		x		x		x		Not Used	
R98	x	x	x	x	x	x	x	10	280-1145P2
R101	x	x		x	x	x	x	Not Used	
			x					1	27-1157
R103	x	x		x	x	x		Not Used	
			x				x	1.8K	280-1145P83
R105	x		x			x	x	11K, 1/8W, 1%	586250-124
		x			x			7.87K, 1/8W, 1%	586250-117
				x				5.62K, 1/8W, 1%	586250-110
								Switches	
S1	x		x		x	x	x	Not Used	
		x		x				Power	45-169
S2	x	x	x	x	x	x	x	Voltage/OVP Set Selector	45-168
								Transformers	
T1	x							Rect. Input	126-3140
		x						" "	126-3124
			x					" "	126-3139
				x				" "	126-3125
					x			" "	126-3138-1
						x		" "	126-3126
							x	" "	126-3138-2
T2	x		x					Control	126-3141
		x		x		x		"	126-3121
					x		x	"	126-3142
T3	x	x	x	x	x	x	x	Pulse	126-3123
								Miscellaneous	
	x	x	x	x	x	x	x	Control Knob (4 Required)	42-274
	x							Printed-Circuit Board Ass'y	190-4118-1
		x						" " " "	190-4118-4
			x					" " " "	190-4118-5

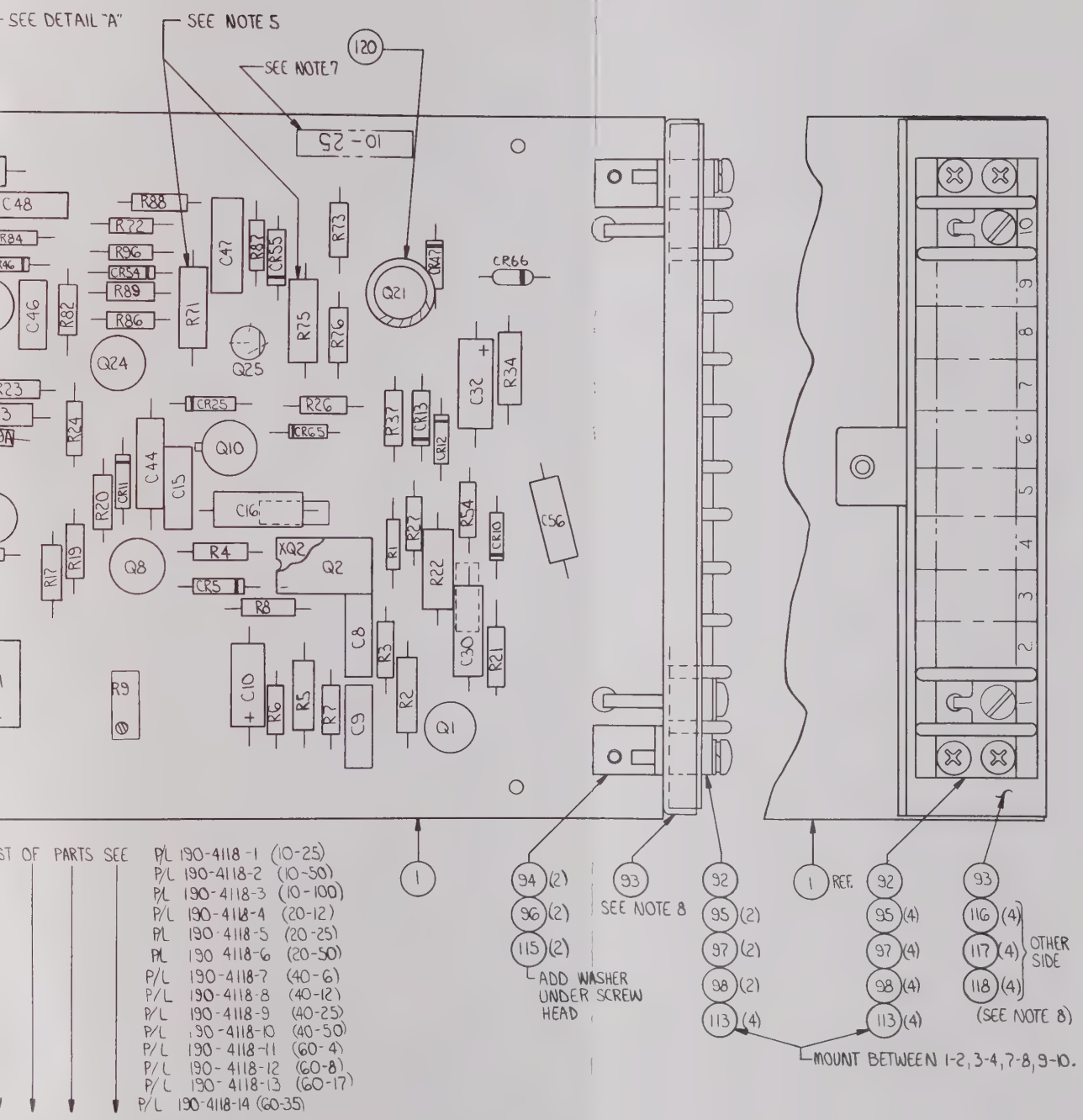
Table 6-1 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Convection Cooled Units

CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Miscellaneous	
			x					Printed-Circuit Board Ass'y	190-4118-7
				x				" " " "	190-4118-8
					x			" " " "	190-4118-11
						x		" " " "	190-4118-12
	x	x	x	x	x	x	x	Cover, Top	73-3200
	x	x	x	x	x	x	x	Cover, Bottom	73-3200
	x		x		x		x	Case Side, Left	73-3270
		x		x		x		" " "	73-3199
	x		x		x		x	Case Side, Right	73-3271
		x		x		x		" " "	73-3199
	x		x		x		x	Handle (2 Required)	91-1245
		x		x		x		" " "	30-784
	x	x	x	x	x	x	x	Foot, Rubber (4 Required)	91-214
	x	x	x	x	x	x	x	Schematic Diagram	586245
	x							Front Panel (No Components)	73-3275-1
		x						" " " "	73-3201-1
			x					" " " "	73-3275-2
				x				" " " "	73-3201-2
					x			" " " "	73-3275-3
						x		" " " "	73-3201-3
							x	" " " "	73-3275-4
E1	x	x	x	x	x	x	x	Binding Post, Black	4-951
E2	x	x	x	x	x	x	x	" " "	4-951
E3	x	x	x	x	x	x	x	" " , Red	4-950
								SRL M1 (210V) and M2 (230V) (Substitute the following components)	
CB1	x							Circuit Breaker, 6A, 250V	92-379
			x		x		x	" " , 10A, 250V	92-380
CR15/16	x	x		x		x		Control Rect.	26-1158-7
			x		x		x	" "	26-178-7
F1		x		x		x		Fuse, 5A, 250V	226-7176P57
F2	x		x					" , 1A, 250V	226-7176P30
		x		x	x	x	x	" , 1/2A, 250V	226-7176P36
	x							Front Panel (Special)	73-3340-1
			x					" " "	73-3340-2
					x			" " "	73-3340-3
							x	" " "	73-3340-4



NOTES:

1. PARTS WITHOUT BALLOONS ARE KEYED TO LIST OF MATERIAL BY REFERENCE DESIGNATION.
2. ALL PROTRUSIONS ON REAR OF BOARD 1/8" MAX., ON FRONT OF BOARD 15/16" MAX.
4. THE QUANTITY PER UNIT IS INDICATED IN PARENTHESIS AFTER PART NUMBER IN RESPECTIVE COLUMNS.
5. THE FOLLOWING COMPONENTS ARE TO BE MOUNTED APPROXIMATELY 1/8" OFF BOARD: R71 & R75 ALL MODELS & CR26 ON E190-4118-1, -5, -9, -13 & -14. (METAL SHELL)
6. USE JUMPER 1/N91 WHEN Q11 & R30 ARE NOT USED, SLEEVE R30 JUMPER
7. RUBBER STAMP, WITH WHITE INK 1/8" HIGH CHARACTERS, THE CORRECT MODEL NUMBER AFTER FLUX REMOVAL PROCESS, APPROXIMATELY IN AREA AS SHOWN.
8. REAR PANEL SUB-ASSY, MOUNTED TO PC BOARD AFTER DIP SOLDERING OPERATION. MASK TB2 MTG. HOLES FROM DIP SOLDERING.
9. POTS R9, R15, RG3, R78, MOUNTING HOLES TO BE MASKED DURING DIP SOLDERING. MOUNT POTS AFTER DIP SOLDERING AND HAND SOLDER.



ST OF PARTS SEE

P/L 190-4118-1 (10-25)
P/L 190-4118-2 (10-50)
P/L 190-4118-3 (10-100)
P/L 190-4118-4 (20-12)
P/L 190-4118-5 (20-25)
P/L 190-4118-6 (20-50)
P/L 190-4118-7 (40-6)
P/L 190-4118-8 (40-12)
P/L 190-4118-9 (40-25)
P/L 190-4118-10 (40-50)
P/L 190-4118-11 (60-4)
P/L 190-4118-12 (60-8)
P/L 190-4118-13 (60-17)
P/L 190-4118-14 (60-35)

Figure 6-3 PCB Component Layout (All units)

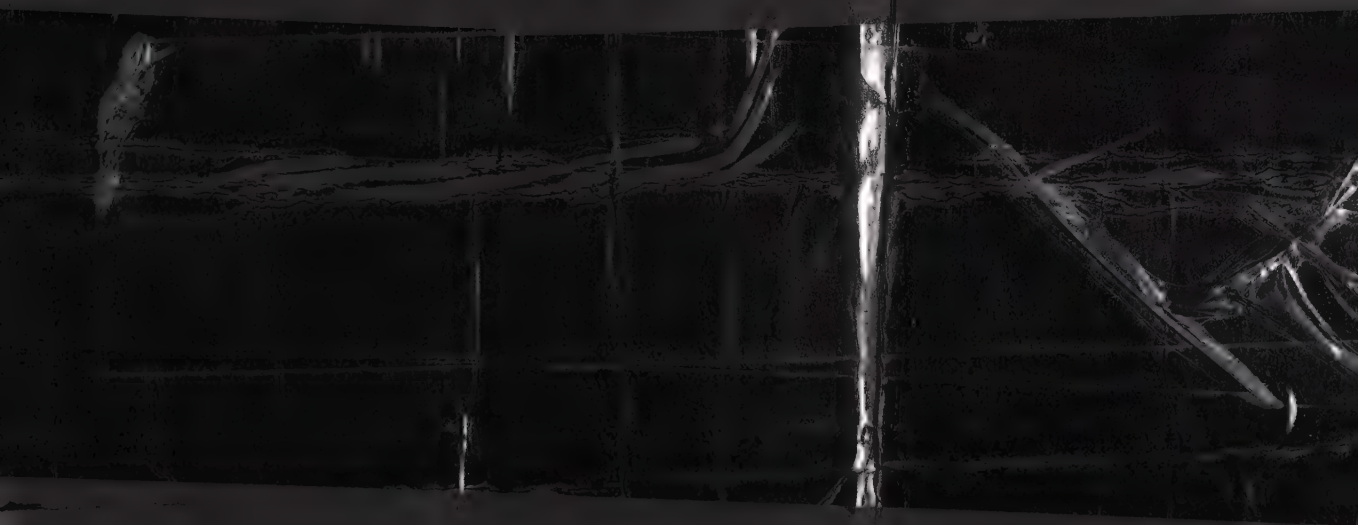


Table 6-2
Replaceable Parts List
PCB Assembly
SRL Convection Cooled Units

CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Capacitors (µF unless noted)	
C6	x	x	x	x	x	x	x	1,000, 15V	24-2554-4
C7	x	x	x	x	x	x	x	1,000, 15V	24-2554-4
C8	x	x	x	x	x	x	x	0.015, 250V	24-2015-3
C9	x	x	x	x	x	x	x	0.033, 250V	24-2015-7
C10	x	x	x	x	x	x	x	20, 12V	235-7404P31
C11	x	x	x	x	x	x	x	25, 75V	235-7404P11
C12	x	x	x	x	x	x	x	0.1, 250V	24-2015-13
C13	x	x	x		x			0.01, 250V	24-2015-1
				x		x	x	0.0022, 200V	24-2409-3
C14	x	x	x	x	x	x	x	0.068, 250V	24-2015-11
C15	x	x	x	x	x	x	x	0.068, 250V	24-2015-11
C16	x	x	x	x	x	x	x	0.01, 250V	24-2015-1
C21	x		x		x		x	6,800, 20V	24-2459-1
		x						1,500, 40V	24-2453-1
			x		x			800, 40V	24-2453-3
C22	x	x	x	x	x	x	x	22, 35V	586058-23
C24	x							0.047, 250V	24-2015-9
		x	x					0.01, 250V	24-2015-1
				x	x	x	x	0.001, 100V	235-7355P266
C25	x		x					0.001, 200V	24-2409-1
		x		x	x	x	x	0.0033, 200V	24-2409-4
C27	x	x	x		x			0.01, 250V	24-2015-1
				x		x	x	Not Used	
C30	x							0.01, 250V	24-2015-1
		x			x			0.0022, 200V	24-2409-3
			x					0.015, 200V	24-2015-3
				x				0.0015, 200V	24-2409-2
						x		0.001, 200V	24-2409-1
							x	0.01, 200V	24-2409-7
C32	x	x	x	x	x	x	x	4, 25V	235-7404P35
C38	x	x	x	x	x	x	x	100, 25V	237-7404P8
C39	x	x	x	x	x	x	x	0.1, 250V	24-2015-13
C40	x	x	x	x	x	x	x	1.8, 250V	24-2015-28
C41	x	x	x	x	x	x	x	Not Used	
C43	x	x	x	x	x	x	x	0.001, 200V	24-2409-1
C44	x	x	x	x	x	x	x	0.0022, 200V	24-2409-3
C45	x	x	x	x	x	x	x	10, 200V	24-2496
C46	x	x	x	x	x	x	x	0.01, 250V	24-2015-1
C47	x	x	x	x	x	x	x	0.1, 250V	24-2015-13
C48	x	x	x	x	x	x	x	0.1, 250V	24-2015-13
C49	x	x	x	x	x	x	x	Not Used	
C51	x	x	x	x	x	x	x	0.047, 250V	24-2015-9
								Diodes	
CR1	x	x	x	x	x	x	x	S11	587565-1
CR2	x	x	x	x	x	x	x	S11	587565-1
CR3	x	x	x	x	x	x	x	S11	587565-1
CR4	x	x	x	x	x	x	x	S11	587565-1
CR5	x	x	x	x	x	x	x	1N825, Zener, 6.2V	588105-3
CR6	x	x	x	x	x	x	x	RD5637	26-1017
CR7	x	x	x	x	x	x	x	RD5637	26-1017
CR8	x	x	x	x	x	x	x	RD5637	26-1017
CR9	x	x	x	x	x	x	x	Not Used	
CR10	x	x	x	x	x	x	x	RD5637	26-1017
CR11	x	x	x	x	x	x	x	RD5637	26-1017
CR12	x	x	x	x	x	x	x	RD5637	26-1017
CR13	x	x	x	x	x	x	x	RD5637	26-1017
CR19A/B	x	x	x	x	x	x	x	S11	587565-1

Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Convection Cooled Units

CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Diodes	
CR24	x	x	x	x	x	x		S16	587565-4
CR25	x	x	x	x	x	x		RD5637	26-1017
CR26	x		x					1N4720	26-1006-2
		x		x	x	x		S11	587565-1
CR29	x	x	x	x	x	x		1N750, Zener, 4.7V	26-211
CR30	x	x	x	x	x	x		RD5637	26-1017
CR31	x	x	x	x	x	x		RD5637	26-1017
CR33	x	x	x	x	x	x		RD5637	26-1017
CR34	x	x	x	x	x	x		RD5637	26-1017
CR37	x	x	x	x	x	x		RD5637	26-1017
CR38	x	x	x	x	x	x		1N4747A, Zener	588102-13
CR39	x	x	x	x	x	x		RD5637	26-1017
CR40	x	x	x	x	x	x		RD5637	26-1017
CR41	x	x	x	x	x	x		1N5226B, Zener, 3.3V	588101-3
CR42	x	x	x	x	x	x		RD5637	26-1017
CR43	x	x	x	x	x	x		RD5637	26-1017
CR44	x	x	x	x	x	x		RD5637	26-1017
CR45	x	x	x	x	x	x		C106A21	26-1105
CR46	x	x	x	x	x	x		RD5637	26-1017
CR47	x	x	x	x	x	x		1N5226B, Zener, 3.3V	588101-3
CR48	x	x	x	x	x	x		RD5637	26-1017
CR51	x	x	x	x	x	x		RD5637	26-1017
CR52	x	x	x	x	x	x		RD5637	26-1017
CR53	x	x	x	x	x	x		RD5637	26-1017
CR54	x	x	x	x	x	x		RD5637	26-1017
CR55	x	x	x	x	x	x		RD5637	26-1017
CR56	x	x	x	x	x	x		RD5637	26-1017
CR58	x	x	x	x	x	x		RD5637	26-1017
CR59					x	x		RD5637	26-1017
CR60	x	x	x	x	x	x		RD5637	26-1017
CR63	x	x	x	x	x	x		RD5637	26-1017
CR65	x	x	x	x	x	x		SS2996	587306-4
CR66	x	x	x	x	x	x		RD5637	26-1017
								Transistors	
Q1	x	x	x	x	x	x		RT9338	18-146
Q2	x	x	x	x	x	x		CA3046 (IC, Transistor Array)	18-605
Q3	x	x	x	x	x	x		CA3046 (IC, Transistor Array)	18-605
Q4	x	x	x	x	x	x		2N3638	18-143
Q5	x	x	x	x	x	x		Dual SA1448	18-176
Q6	x	x	x	x	x	x		2N2907A	386-7249P58
Q7	x	x	x	x	x	x		2N3638	18-143
Q8	x	x	x	x	x	x		2N3638	18-143
Q9	x	x	x					2N697	18-115
				x	x			2N3019	386-7316P1
						x	x	40321	18-165
Q10	x	x	x	x	x	x	x	CA3053 (IC, Diff. Amp)	18-606
Q11	x	x	x					40312	18-142
Q14	x	x	x					2N697	18-115
				x	x			2N3019	386-7316P1
						x	x	40321	18-165
Q15	x	x	x	x	x	x	x	2N3641	18-144
Q16	x	x	x	x	x	x	x	2N1671A	18-097
Q17	x	x	x	x	x	x	x	2N3641	18-144
Q18	x	x	x	x	x	x	x	2N3638	18-143
Q19	x	x	x	x	x	x	x	2N3638	18-143
Q20	x	x	x	x	x	x	x	2N3641	18-144
Q21	x	x	x	x	x	x	x	2N5415	18-216
Q22	x	x	x	x	x	x	x	2N3638	18-143

Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Convection Cooled Units

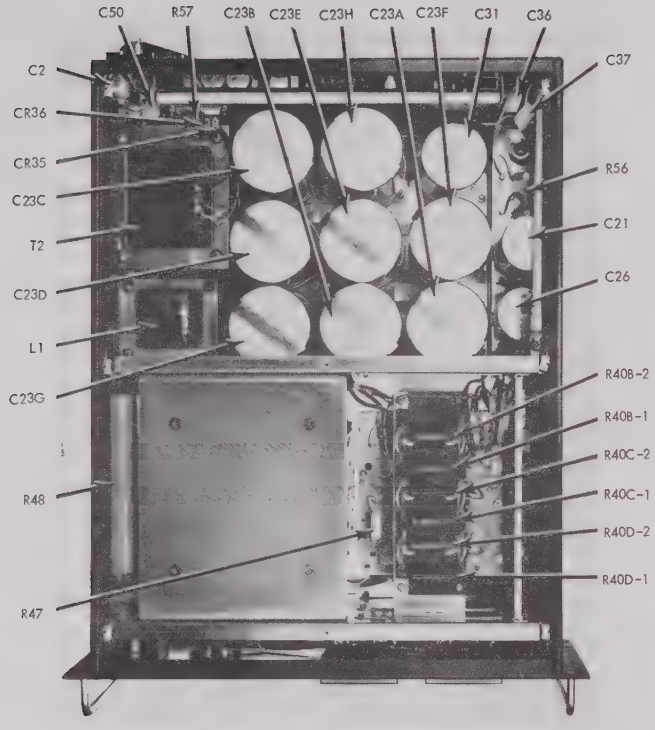
CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Transistors	
Q23	x							2N3638	18-143
		x	x	x	x	x	x	62940	587062-1
Q24	x							2N3638	18-143
		x	x	x	x	x	x	62940	587062-1
Q25	x	x	x	x	x	x	x	2N5307	18-214
								Resistors (ohms, 1/2W, ±10% unless noted)	
R1	x	x	x	x	x	x	x	220	280-1145P50
R2	x	x	x	x	x	x	x	390, 1W	280-1180P59
R3	x	x	x	x	x	x	x	10	280-1145P2
R4	x	x	x	x	x	x	x	680	280-1145P68
R5	x	x	x	x	x	x	x	357, 1/8W, 1%	28-1285
R6	x	x	x	x	x	x	x	1K	280-1145P74
R7	x	x	x	x	x	x	x	1K	280-1145P74
R8	x	x	x	x	x	x	x	1.2K	280-1145P77
R9	x	x	x	x	x	x	x	2K, 2W, Variable	29-519
R10	x	x	x	x	x	x	x	47K	280-1145P134
R11	x	x	x	x	x	x	x	1.5K	280-1145P80
R12	x	x	x	x	x	x	x	2.2K	280-1145P86
R13	x	x	x	x	x	x	x	820	280-1145P71
R14	x	x	x	x	x	x	x	3.3K	280-1145P91
R15	x	x	x	x	x	x	x	50, 2W, 20%, Variable	29-467
R16	x	x	x	x	x	x	x	47	280-1145P26
R17	x		x					4.32K, 1/8W, 1%	586055-190
		x		x	x	x	x	2.15K, 1/8W, 1%	28-1415
R19	x	x	x	x	x	x	x	330	280-1145P56
R20	x	x	x	x	x	x	x	390	280-1145P59
R21	x	x	x	x	x	x	x	1.78K, 1%	28-1373
R22	x	x	x	x	x	x	x	560, 1W	280-1180P65
R23	x	x	x	x	x	x	x	2.2K	280-1145P86
R24	x	x	x	x	x	x	x	2.2K	280-1145P86
R25	x	x	x	x	x	x	x	2.05K, 1/8W, 1%	586055-89
R26	x	x	x	x	x	x	x	560	280-1145P65
R27	x	x	x	x	x	x	x	3.9K	280-1145P95
R28	x	x	x	x	x	x	x	330, 1W	280-1180P56
R29	x							604K, 1%	28-1267
		x				x		316K, 1%	28-1397
			x					1.21M, 1%	28-1358
				x				332K, 1%	28-1357
					x		x	634K, 1%	28-1398
R30	x	x	x	x	x	x	x	1	27-983
R31	x	x	x	x	x	x	x	2.7K	280-1145P89
R32	x	x	x	x	x	x	x	2.7K	280-1145P89
R33	x	x	x	x	x	x	x	6.49K, 1/8W, 1%	586055-113
R34	x	x	x	x	x	x	x	560, 1W	280-1180P65
R35	x	x	x		x			22K	280-1145P122
				x		x	x	Not Used	
R36	x	x	x	x	x	x	x	5.6K, 5%	280-1145P100
R37	x	x	x	x	x	x	x	220	280-1145P50
R44	x	x	x	x	x	x	x	2.2K	280-1145P86
R45	x		x					1.2K	280-1145P77
		x						2.2K	280-1145P86
				x	x	x	x	Not Used	
R46	x		x					1.2K	280-1145P77
		x		x	x	x	x	2.2K, 1W	280-1180P86
R49	x							18K	280-1145P119
		x	x					33K	280-1145P128
				x	x	x	x	47K	280-1145P134

Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Convection Cooled Units

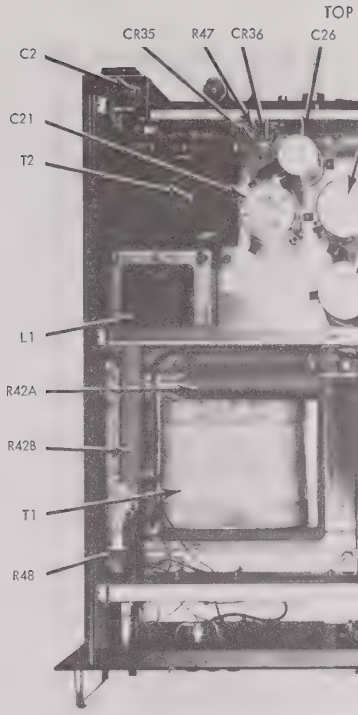
CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Resistors (ohms, 1/2W, ±10% unless noted)	
R50	x	x	x	x	x	x	x	2.2K	280-1145P86
R51	x	x	x	x	x	x	x	12K	280-1145P113
R52	x		x					10K	280-1145P110
		x		x	x	x	x	4.7K	280-1145P98
R54	x	x	x	x	x	x	x	47	280-1145P26
R58	x	x	x	x	x	x	x	390	280-1145P59
R59	x	x	x	x	x	x	x	150K	280-1145P152
R60	x	x	x	x	x	x	x	3.9K	280-1145P95
R61	x	x	x	x	x	x	x	3.3K	280-1145P91
R62	x							330	280-1145P56
		x	x					680	280-1145P68
				x	x			820	280-1145P71
						x	x	1K	280-1145P74
R63	x		x					1K, 2W, Variable	29-503
		x		x	x	x	x	400, 2W, Variable	29-547
R64	x	x	x	x	x	x	x	6.8K	280-1145P104
R65	x							4.7K	280-1145P98
		x	x					12K	280-1145P113
				x	x			22K	280-1145P122
						x	x	33K	280-1145P128
R66	x							5.6K	280-1145P100
		x	x					10K	280-1145P110
				x	x			18K	280-1145P119
						x	x	27K	280-1145P125
R68	x	x	x	x	x	x	x	3.3K	280-1145P91
R69	x	x	x	x	x	x	x	220	280-1145P50
R70	x	x	x	x	x	x	x	10K	280-1145P110
R71	x	x	x	x	x	x	x	30K, 2W	585109-56
R72	x	x	x	x	x	x	x	820K	280-1145P179
R73	x	x	x	x	x	x	x	237, 1/4W, 1%	28-1418
R74	x	x	x	x	x	x	x	4.7K	280-1145P98
R75	x	x	x	x	x	x	x	27K, 2W	585109-55
R76	x	x	x	x	x	x	x	120K	280-1145P149
R78	x	x	x	x	x	x	x	5K, 2W, Variable	29-426
R79	x	x	x	x	x	x	x	2.7K	280-1145P89
R80	x	x	x	x	x	x	x	1.2K	280-1145P77
R81	x	x	x	x	x	x	x	470	280-1145P62
R82	x	x	x	x	x	x	x	4.7K	280-1145P98
R84	x	x	x	x	x	x	x	470	280-1145P62
R86	x	x	x	x	x	x	x	1K	280-1145P74
R87	x	x	x	x	x	x	x	1.0 Meg, 1/4W, 1%	28-1418
R88	x	x	x	x	x	x	x	3.3 Meg	280-1145P200
R89	x							27K	280-1145P125
		x	x					22K	280-1145P122
				x	x			18K	280-1145P119
						x	x	15K	280-1145P116
R92	x							150	280-1145P44
		x	x	x	x	x	x	100	280-1145P38
R96	x	x	x	x	x	x	x	10K, 1/4W, 1%	28-1325
R99	x	x	x	x	x	x	x	470K	280-1145P170
R102	x	x	x	x	x			Not Used	
						x	x	12K	280-1145P113
TB2	x	x	x	x	x	x	x	Terminal Board	90-3837
U1	x	x	x	x	x	x	x	LM741CH	585322-1

Table 6-2 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Convection Cooled Units

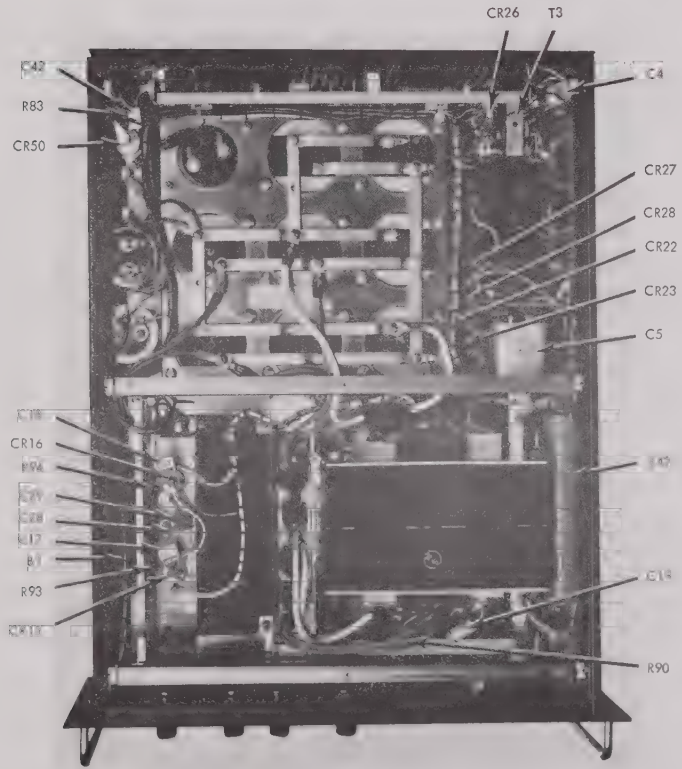
CIRCUIT SYMBOL	SRL Model 10-25	20-12	20-25	40-6	40-12	60-4	60-8	DESCRIPTION	SORENSEN PART NUMBER
								Miscellaneous	
XQ2	x	x	x	x	x	x	x	Socket (IC)	585741-1
XQ3	x	x	x	x	x	x	x	" "	585741-1
	x							Printed-Circuit Board Ass'y	190-4118-1
		x						" " " "	190-4118-4
			x					" " " "	190-4118-5
				x				" " " "	190-4118-7
					x			" " " "	190-4118-8
						x		" " " "	190-4118-11
							x	" " " "	190-4118-12



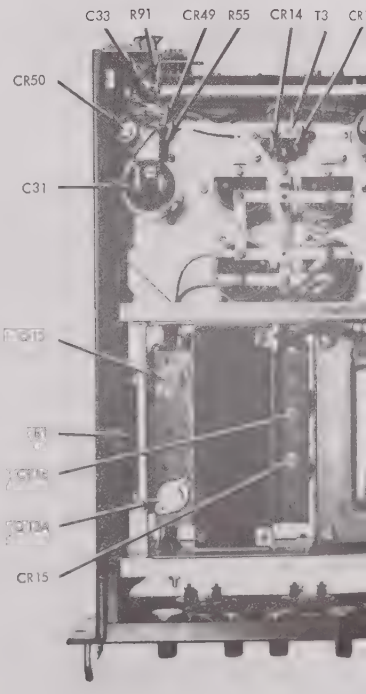
UNITS 10-50, 40-25, 10-100(SHOWN)



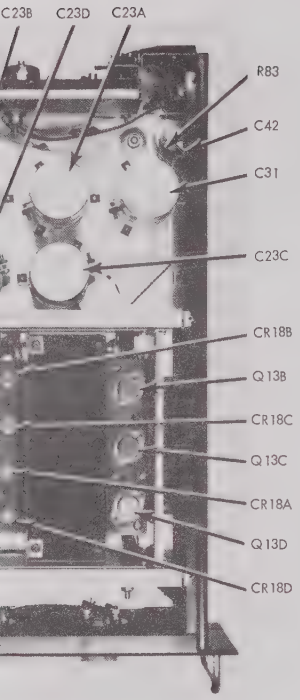
SRL 60-1

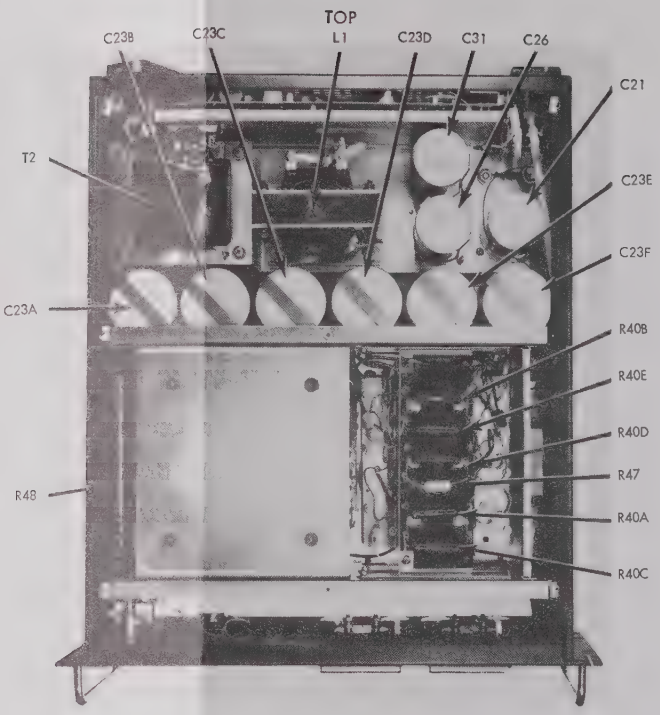


BOTTOM

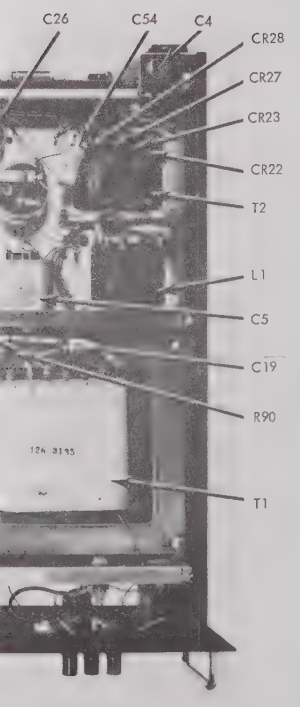


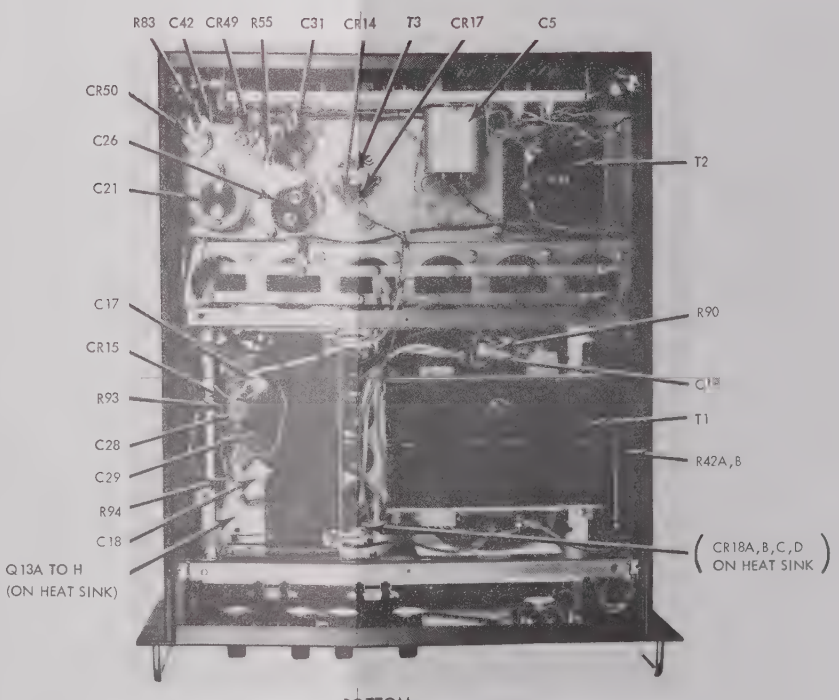
BOTTO





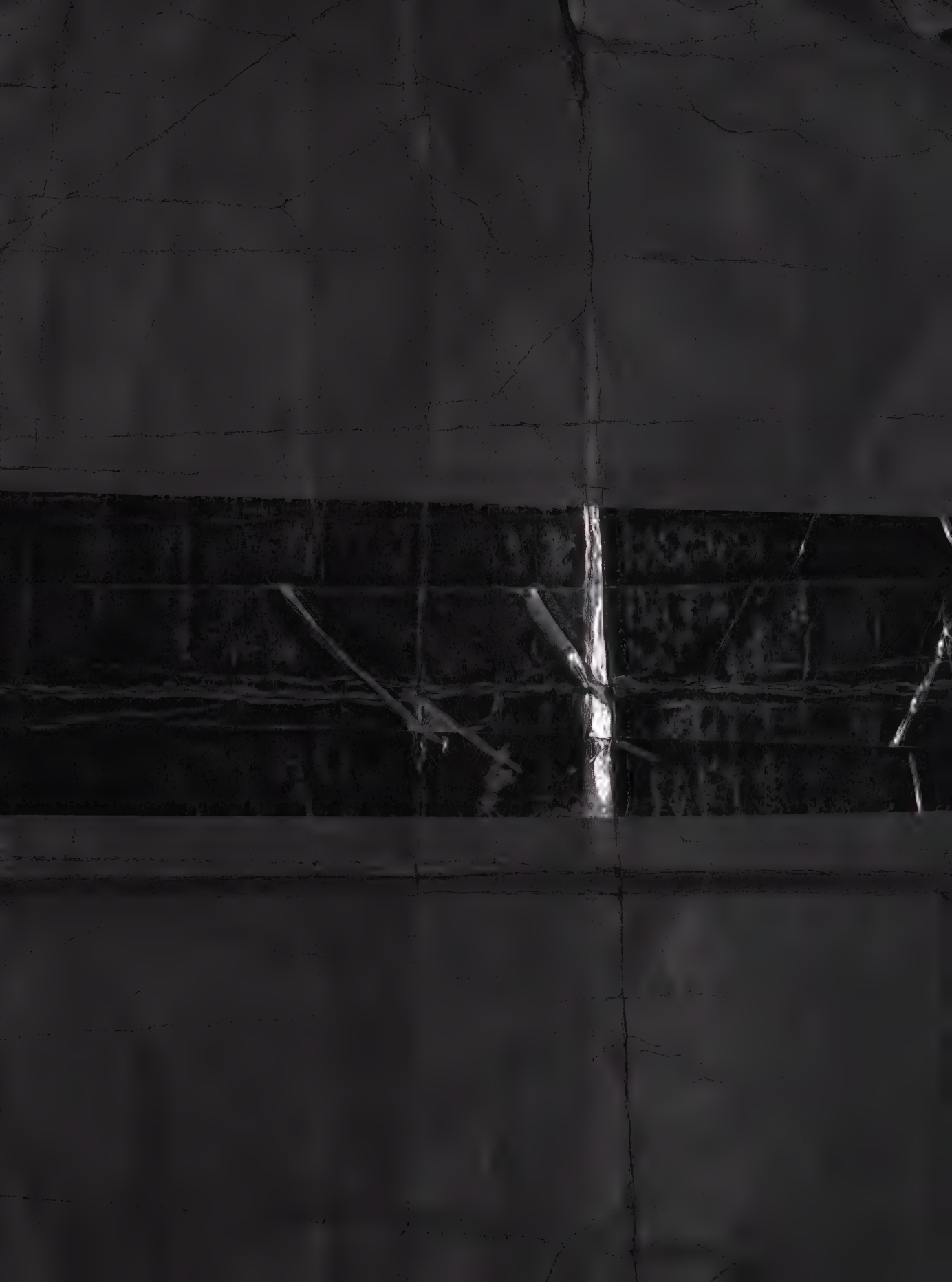
UNITS 20-50, 60-35, 40-50 (SHOWN)

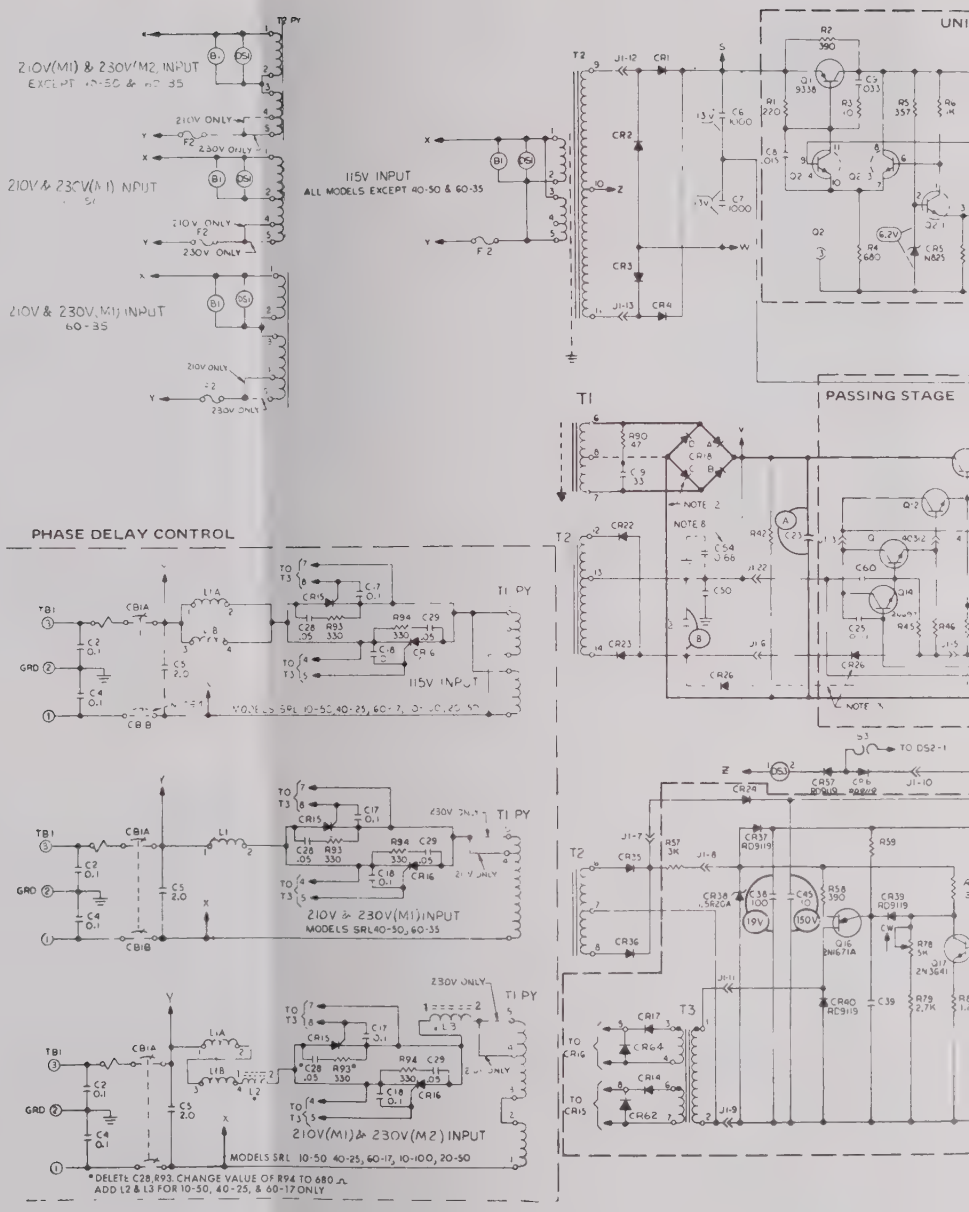




BOTTOM

Figure 6-4 Typical Chassis Assemblies
SRL Fan Cooled Units

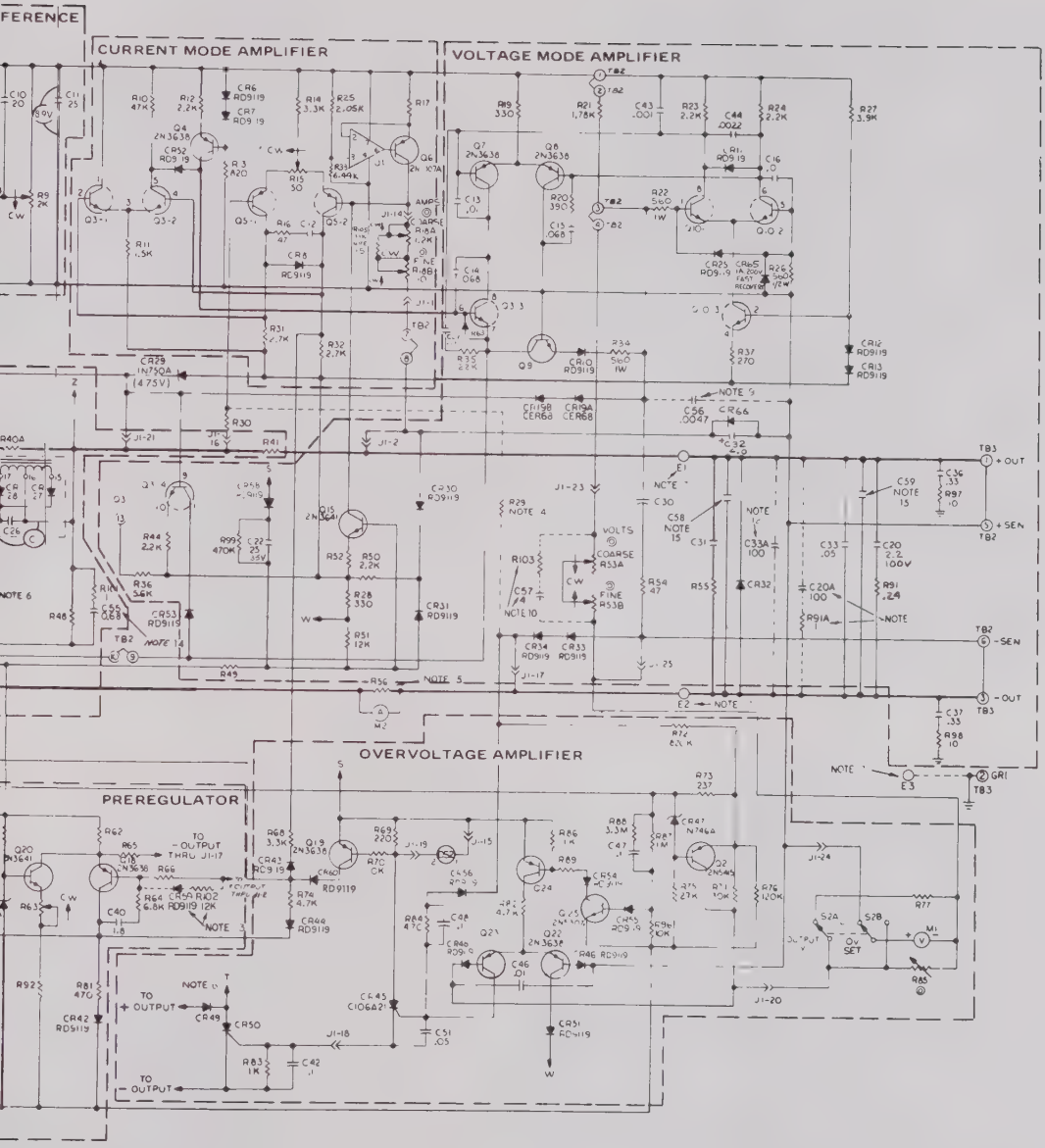




*SELECTED FOR VOLTAGE BREAKDOWN CHARACTERISTICS

UNIT	C12	C13	C 21	C 23	C60	C25	C 26	C 30	C 31	C 50	Q 9	Q 12	Q 13	Q 23	Q 24	R 17	R 29	R 30
10-50	.22	.01	15K	7 X 69K	047	.001	9.6K	.01	6.4K	0.15	2N 697	2N 3055	2N 3771 (4)	2N 3638	2N 3638	5.36K		0
10-100	.22	.01	23K	8 X 85K	047	.001	21K	.015	26K	.33	2N 697	2N 3771	2N 3771 (7)	2N 3638	2N 3638	8.66K		0
20-50	.1	.01	15K	7 X 26K	.01	001	9.6K	.0033	6.7K	.33	2N 697	2N 3055	2N 3771 (5)	RCA62490	RCA62490	5.36K		0
40-25	.1	.01	4.7K	6 X 9.4K	01	.001	9.6K	.0022	3.2K	0.15	2N 697*	2N 3055	2N 3055 (4)*	RCA62490	RCA62490	4.32K	2.49M	1
40-50	.1	.01	8.7K	6 X 21K	01	.001	21K	.0022	5.8K	.33	2N 697*	2N 3055	2N 3055 (8)*	RCA62490	RCA62490	5.36K		0
60-17	.1	.01	4.7K	4 X 6.5K	.01	.001	9.6K	.001	2.5K	0.33	40321	2N 3055	2N 3442 (4)	RCA62490*	RCA62490*	3.16K	2M	1
60-35	.1	.01	4.7K	8 X 6.5K	01	.001	21K	.0022	6.5K	.33	40321	2N 3055	2N 3442 (8)	RCA62490*	RCA62490*	4.12K		0

UNIT	R 41	R 42	R 45	R 46	R 47	R 48	R 49	R 52	R 53A	R 53B	R 55	R 56	R 62	R 63	R 65	R 66	R 77	R 85	R 89	R 92	R 103
10-50	.008	5	1.2K	1.2K	220	3	18K	12K	2K	20	.02	60A	470	1K	4.7K	5.6K	12.1K	3K	27K	150	
10-100	.0025	3	1.2K	1.2K	125	1.0	18K	20K	2K	20	.015	120A	470	1K	4.7K	5.6K	12.1K	3K	27K	150	3.3K
20-50	.008	10	1.2K	1.2K	150	2	33K	12K	4K	40	.055	60A	680	1K	12K	10K	24.9K	4K	22K	100	
40-25	.020	25 (2) ser.	2.2K	2.2K	390	10	33K	9K	8K	80	.14		820	1K	22K	18K	49.9K	8K	18K	100	
40-50	.008	50 (2) par.	2.2K	2.2K	180	5	33K	11K	8K	80	.055	60A	820	1K	22K	18K	49.9K	8K	18K	100	
60-17	.040	50 (2) ser.	2.2K	2/2K	300	15	47K	7.5K	12K	120	.185		1K	500	33K	27K	80.6K	12K	15K	100	
60-35	.015	100 (2) par.	2.2K	2.2K	150	10	47K	10K	12K	120	.120	40A	1K	500	33K	27K	80.6K	12K	15K	100	6.8K



Notes:

1. CB 1-8 used only on 10-100 and 20-50 (115 Input) of this group.
2. CR18C and D not used on 20-50, 10-50, 10-100 and indicated lead is wired to T 1-8.
3. CR26 relocated to dotted position on models 10-50, 10-100, 20-50 and 40-50.
4. R29 not used on 10-50, 10-100, 20-50, 40-50, 60-35.
5. Shunt R56 used on units 35 amp output and up.
6. CR49 inserted and indicated lead "T" used only on 40-25, 40-50, 60-17 and 60-35.
7. E1, E2 and E3 not used on models 20-50, 40-50, 60-35, and 10-100.
8. C54 used only on 10-50, 40-25 and 60-17.
9. C56 used only on 10-100 and 40-50.
10. C57 and R103 used only on 10-100, 60-35.
11. C20A and R91A used only on 20-50.
12. C33A used only on 40-50 and 10-100.
13. CR59 and R102 used only on 60-17 and 60-35.
14. C55 is 2.0μFD200V and R101 is short circuit for model SRL 40-25
15. Add C58 and C59 for 10-50, 40-25, 60-17 only (M1 & M2)
16. R105 MAY BE OMITTED IN SOME UNITS, AS DETERMINED BY TEST LIMITS.

UNIT	F2 115V	F2 210V	F2 230V
10-50	2.0A SB	1¼A SB	1¼A SB
10-100	4.0A SB	2¼A SB	2½A SB
20-50	2.0A SB	1¼A SB	1¼A SB
40-25	2.0A SB	1.0A SB	1.0A SB
40-50		2¼A SB	2½A SB
60-17	1.5A	1A	1A
60-35		1¼A SB	1¼A SB

VOLTAGE CHART

MODEL	A C23	B (C21)	C (C26)
10-50	15.5	14	11
10-100	15.5	14	11
20-50	27.0	14	11
40-25	50.0	27	9
40-50	48.5	27	9
60-17	73.[illegible]	27	9
60-35	73.4	27	9

C39
.10
.22
.22
.22
.22
.22
.22

Figure 6-5 SRL Fan Cooled Units Schematic Diagram

Table 6-3
Replaceable Parts List
Main Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
B1	x	x	x	x	x	x	x	Fan	91-1000-2
								Capacitors (uF unless noted)	
C1	x	x	x	x	x	x	x	Not Used	
C2	x	x	x	x	x	x	x	0.1, 360V	166374-7
C3	x	x	x	x	x	x	x	Not Used	
C4	x	x	x	x	x	x	x	0.1, 360V	166374-7
C5	x	x	x	x	x	x	x	2, 330V	23-369
C17	x	x	x	x	x	x	x	0.1, 250V	587626-65
C18	x	x	x	x	x	x	x	0.1, 250V	587626-65
C19	x	x	x	x	x	x	x	0.33, 200V	24-2409-16
C20	x	x	x	x	x	x	x	2.2, 100V	587626-12
C20A	x	x		x	x	x	x	Not Used	
			x					100, 25V	235-7404P8
C21	x		x					15K, 20V	24-2459-2
		x						23K, 20V	24-2459-4
				x		x	x	4.7K, 40V	24-2460-2
					x			8.7K, 50V	24-2445-9
C23	x							69K, 15V (7 Required)	24-2594-1
		x						85K, 20V (8 Required)	24-2459-5
			x					26K, 30V (7 Required)	24-2444-7
				x				9.4K, 50V (6 Required)	24-2595-1
					x			21K, 50V (6 Required)	24-2595-2
						x		6.5K, 75V (4 Required)	24-2593-1
							x	6.5K, 75V (8 Required)	24-2593-1
C26	x		x	x		x		9.6K, 15V	24-2454-8
		x			x		x	21K, 15V	24-2454-3
C28	x	x	x	x	x	x	x	0.05, 500V	24-2010
C29	x	x	x	x	x	x	x	0.05, 500V	24-2010
C31	x							6.4K, 15V	24-2454-4
		x						26K, 30V	24-2444-7
			x					6.7K, 30V	24-2444-4
				x				3.2K, 40V	24-2460-1
					x			5.8K, 50V	24-2445-8
						x		2.5K, 75V	24-2525-4
							x	6.5K, 75V	24-2593-1
C33	x	x	x	x	x	x	x	0.05, 500V	24-2010
C33A	x		x	x		x	x	Not Used	
		x						100, 15V	24-2554-1
					x			100, 50V	24-2556-2
C34	x	x	x	x	x	x	x	Not Used	
C35	x	x	x	x	x	x	x	Not Used	
C36	x	x	x	x	x	x	x	0.33, 250V	587626-68
C37	x	x	x	x	x	x	x	0.33, 250V	587626-68
C50	x			x				0.15, 400V	24-2411-14
		x	x		x	x	x	0.33, 400V	24-2411-16
C54	x			x		x		0.68, 400V	24-2411-18
		x	x		x		x	Not Used	
C55	x	x	x		x	x	x	0.68, 200V	24-2409-18
				x				2, 200V	24-2409-21
C57	x		x	x	x	x		Not Used	
		x					x	4, 150V	24-2288-1
C58								210/230V only (See page 6-)	
C59								210/230V only (See page 6-)	
C61	X			X		X		3.3, 35V	586058-13
CB1**	x							Circuit Breaker	92-375
		x						" "	92-384
			x		x		x	" "	92-383
				x		x		" "	92-376

*Includes all components not on PCB.
**115V input only, see page 6-34 for 210/230 volt.

Table 6-3 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Diodes	
CR14	x	x	x	x	x	x	x	S11	587565-1
CR15*	x							C230CX7	26-178-5
		x						C137CX80	26-1164
			x	x		x		C137CX77	26-1159-1
					x		x	C137E	26-1159-3
CR16*	x							C230CX7	26-178-5
		x						C137CX80	26-1164
			x	x		x		C137CX77	26-1159-1
					x		x	C137E	26-1159-3
CR17	x	x	x	x	x	x	x	S11	587565-1
CR18A	x		x		x		x	154K20A	587571-6
		x						154K10A	587571-1
				x		x		1N1186A	587382-3
CR18B	x		x		x		x	154K20A	587571-6
		x						154K10A	587571-1
				x		x		1N1186A	587382-3
CR18C				x				1N1186A	587382-3
					x		x	154KR20A	587571-8
CR18D				x				1N1186A	587382-3
					x		x	154KR20A	587571-8
CR19A	x	x	x	x	x	x	x	S11	587565-1
CR19B	x	x	x	x	x	x	x	S11	587565-1
CR22	x			x			x	3S11	587566-1
		x			x			1N1200A	587393-1
			x					1N4720	26-1006-2
						x		S11	587565-1
CR23	x			x			x	3S11	587566-1
		x			x			1N1200A	587393-1
			x					1N4720	26-1006-2
						x		S11	587565-1
CR27	x		x	x				3S11	587566-1
		x			x			1N1200A	587393-1
						x		Not Used	
							x	1N4720	26-1006-2
CR28	x		x	x				3S11	587566-1
		x			x			1N1200A	587566-1
						x		Not Used	
							x	1N4720	26-1006-2
CR32	x	x	x	x	x	x	x	1N1184A	587382-2
CR35	x	x	x	x	x	x	x	S16	587565-4
CR36	x	x	x	x	x	x	x	S16	587565-4
CR49	x	x	x					Not Used	
				x	x	x	x	1N1184A	587382-2
CR50	x	x						C45U	26-1161-1
			x					C45F	26-1161-2
				x	x	x	x	C45A	26-1161-3
CR57	x	x	x	x	x	x	x	RD5637	26-1017
CR61	x	x	x	x	x	x	x	RD5637	26-1017
CR62	x	x	x	x	x	x	x	S11	587565-1
CR64	x	x	x	x	x	x	x	S11	587565-1
DS1	x	x	x	x	x	x	x	Power Indicator	43-357
DS2	x	x	x	x	x	x	x	Overvoltage Indicator	43-358
DS3	x	x	x	x	x	x	x	Thermal Indicator	43-358

*115V input only, see page 6- 34for 210/230 volt.

Table 6-3 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Fuses	
F1	x	x	x	x	x	x	x	Not Used	
F2*	x		x	x		x		2A, 125V, SB	226-7177P22
		x						4A, 125V, SB	226-7177P14
				x				2.5A, 250V, SB	226-7177P77
						x		1.25A, 250V, SB	226-7177P25
XF2	x	x	x	x	x	x	x	Fuseholder	343-1011P2
L1**	x							RFI Choke	127-1846
		x	x	x		x		" "	127-1847
				x		x		" "	127-1851
M1	x	x						Voltmeter, 0-12V	94-579-1
			x					" , 0-25V	94-579-2
				x	x			" , 0-50V	94-579-3
					x	x		" , 0-80V	94-579-4
M2	x		x		x			Ammeter, 0-60A	94-462-8
		x						" , 0-120A	94-462-9
				x				" , 0-30A	94-462-6
					x			" , 0-20A	94-462-5
						x		" , 0-40A	94-462-7
								Transistors	
Q12	x		x	x	x	x	x	2N3055A	18-151
		x						2N3771	18-202
Q13	x							2N3771 (4 Required)	18-202
		x						2N3771 (7 Required)	18-202
			x					2N3771 (5 Required)	18-202
				x				2N3055 (Selected - 4 Required)	18-178-1
					x			2N3055 (Selected - 8 Required)	18-178-1
						x		2N3442 (4 Required)	18-163
							x	2N3442 (8 Required)	18-163
								Resistors (ohms, 1/2W, ±10 unless noted)	
R18A	x	x	x	x	x	x	x	1.2K, 2W, Variable	29-596
R18B	x	x	x	x	x	x	x	10, 2W, Variable	29-595
R40	x							0.18, 12.5W, 5% (8 Required)	27-590-7
		x						0.18, 12.5W, 5% (14 Required)	27-590-7
				x				0.18, 12.5W, 5% (4 Required)	27-590-7
					x			0.18, 12.5W, 5% (8 Required)	27-590-7
			x					0.1, 12.5W, 5% (5 Required)	27-590-1
						x		0.33, 12.5W, 5% (4 Required)	27-590-13
							x	0.33, 12.5W, 5% (8 Required)	27-590-13
R41	x							8 Milliohms	190-4159
		x						2.5 Milliohms	190-4165
			x		x			8 Milliohms	190-4178
				x				20 Milliohms	190-4140
					x			40 Milliohms	190-4141
						x		15 Milliohms	190-4179
R42	x							5, 100W	27-827
		x						3, 100W	27-1010
			x					10, 100W	27-867
				x				25, 50W (Series - 2 Required)	27-809
					x			50, 100W(Parallel - 2 Req'd)	27-856
						x		50, 50W (Series - 2 Required)	27-841

*115V input only, see page 6-34 for 210/230 volt.
**L2/L3 added for 210/230 volt inputs, see page 6-34

Table 6-3 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Resistors (ohms, 1/2W, ±10% unless noted)	
R42						x		100, 100W (Parallel - 2 Req'd)	27-1009
R47	x							220, 2W	280-1147P50
		x						125, 5W	28-557
			x					150, 2W	280-1147P44
				x				390, 2W	280-1147P59
					x			180, 5W	27-499-18
						x		300, 2W	280-1147P54
						x		150, 5W	27-499-17
R48	x							3, 50W	27-805
		x						1, 100W	27-826
			x					2, 50W	27-804
				x		x		10, 50W	27-850
					x			5, 100W	27-827
						x		15, 25W	27-744
R53A	x	x						2K, 2W, Variable, +20, -0%	29-587
			x					4K, 2W, Variable, +20, -0%	29-588
				x	x			8K, 2W, Variable, +20, -0%	29-589
						x	x	12K, 2W, Variable, +20, -0%	29-590
R53B	x	x						20, 2W, Variable	29-591
			x					40, 2W, Variable	29-592
				x	x			80, 2W, Variable	29-593
						x	x	120, 2W, Variable	29-594
R55	x							0.02	190-4160
		x						0.015	190-4195
			x		x			0.055	190-4180
				x				0.14	190-4161
						x		0.185	190-4162
							x	0.120	190-4194
R56	x		x					60A, 50mV	588151-7
		x						120A, 50mV	588151-6
				x		x		Not Used	
					x			60A, 50mV	94-043
							x	40A, 50mV	588151-8
R57	x	x	x	x	x	x	x	3K, 7W	27-471-9
R77	x	x						12.1K, 1%	28-1408
			x					24.9K, 1%	28-1261
				x	x			49.9K, 1%	28-1409
						x	x	80.6K, 1%	28-1351
R83	x	x	x	x	x	x	x	1K	280-1145P74
R85	x	x						3K, 2W, Variable	29-597
			x					4K, 2W, Variable	29-598
				x	x			8K, 2W, Variable	29-599
						x	x	12K, 2W, Variable	29-600
R90	x	x	x	x	x	x	x	47	280-1145P26
R91	x	x	x	x	x	x	x	0.24, 2W, 5%	28-1252
R91A	x	x		x	x	x	x	Not Used	
			x					1	27-1157
R93*	x	x	x	x	x	x	x	330, 1/2W	280-1145P56
R94**	x	x	x	x	x	x	x	330, 1/2W	280-1145P56
R95	x	x	x	x	x	x	x	2.2K	280-1145P86
R97	x	x	x	x	x	x	x	10	280-1145P2
R98	x	x	x	x	x	x	x	10	280-1145P2
R101	x	x	x		x	x	x	1	27-1157
R103	x		x	x	x	x		Not Used	
		x						3.3K, 1/2W	280-1145P91
							x	6.8K, 1/2W	280-1145P104
R105	x	x	x	x	x	x	x	11K, 1/8W, 1%	586250-124

*Omitted with 210/230 volt inputs.
**See page 6-34 for 210/230 volt inputs.

Table 6-3 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Switches	
S1	x	x	x	x	x	x	x	Not Used	
S2	x	x	x	x	x	x	x	Voltage/OVP Set Selector	45-168
S3	x	x	x	x	x	x	x	Thermostat, 15A, 120 Vac SPST, (N.O.)	92-516
								Transformers	
T1	x							Rect. Input	126-3133
		x						" "	126-3144
			x					" "	126-3145
				x				" "	126-3134
					x			" "	126-3146-1
						x		" "	126-3135
							x	" "	126-3146-2
T2	x		x					Control	126-3132
		x						"	126-3147-1
			x		x	x		"	126-3131
				x				"	126-3147-2
T3	x		x	x	x	x	x	Pulse	126-3123
		x						"	126-3148
								Miscellaneous	
	x	x	x	x	x	x	x	Control Knobs (4 Required)	42-274
	x							Printed-Circuit Board Ass'y	190-4118-2
		x						" " " "	190-4118-3
			x					" " " "	190-4118-6
				x				" " " "	190-4118-9
					x			" " " "	190-4118-10
						x		" " " "	190-4118-13
							x	" " " "	190-4118-14
	x		x	x	x	x	x	Cover, Top	73-3361
		x						" "	73-3381
	x		x	x	x	x	x	Cover, Bottom	73-3337
		x						" "	73-3266
	x			x		x		Cover, Rear	73-3218
		x	x		x		x	" "	73-3259
	x			x		x		Case Side, Left	73-3210
		x						" " "	73-3264
			x		x		x	" " "	73-3250
	x			x		x		Case Side, Right	73-3209
		x						" " "	73-3263
			x		x		x	" " "	73-3249
	x			x		x		Handle (2 Required)	91-1245
		x	x		x		x	" " "	30-786
	x			x		x		Foot, Rubber (4 Required)	91-214
		x	x		x		x	Foot, Aluminum (4 Required)	30-473
	x	x	x	x	x	x	x	Schematic Diagram	E586246
E1	x	x	x		x		x	Not Used	
				x		x		Binding Post, Black	4-951
E2	x	x	x		x		x	Not Used	
				x		x		Binding Post, Black	4-951
E3	x	x	x		x		x	Not Used	
				x		x		Binding Post, Red	4-950
	x							Front Panel (No Components)	73-3208-1
		x						" " " "	73-3248-1
			x					" " " "	73-3248-2
				x				" " " "	73-3208-2
					x			" " " "	73-3248-3

Table 6-3 (Cont'd)
Replaceable Parts List
Main Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Miscellaneous	
					x			Front Panel (No Components)	73-3208-3
						x		" " " "	73-3248-4
								SRL M1 (210V) and M2 (230V) Modifications*	
C28	x			x		x		Remove Capacitor	
*C58	x							6.8uF, 35V	586058-17
(Connect				x				4.7uF, 50V	585071-37
from E1					x			3.9uF, 75V	586386-5
to E2									
*C59	x							6.8uF, 35V	586058-17
(Connect				x				4.7uF, 50V	585071-37
from					x			3.9uF, 75V	586386-5
TB3-1 to									
TB3-3)									
CB1	x							Circuit Breaker, 10A, 250 Vac	92-381
		x						" " , 23A, 250 Vac	92-385
			x	x	x			" " , 21A, 250 Vac	92-382
CR15	x	x	x	x	x			Cont. Rect., 25A	26-178-7
CR16	x	x	x	x	x			" " , 25A	26-178-7
F2	x		x					Fuse, 1.25A, 250V, SB	226-7177P25
		x						" , 2.5A, 250V, SB	226-7177P77
				x				" , 1A, 250V, SB	226-7177P47
					x			" , 1A, 250V	226-7176P39
L2	x			x	x			Choke Assembly	586936-1
L3	x			x	x			" "	586936-1
R93	x			x	x			Remove Resistor	
R94	x			x	x			Resistor, 680, 1/2W	280-1145P68
	x							Front Panel (Special)	73-3339-1
				x				" " "	73-3339-2
					x			" " "	73-3339-3

*Not required for SRL 40-50/60-35.

Table 6-4
Replaceable Parts List
PCB Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Capacitors (uF unless noted)	
C6	x	x	x	x	x	x	x	1,000, 15V	24-2554-4
C7	x	x	x	x	x	x	x	1,000, 15V	24-2554-4
C8	x	x	x	x	x	x	x	0.015, 250V	24-2015-3
C9	x	x	x	x	x	x	x	0.033, 250V	24-2015-7
C10	x	x	x	x	x	x	x	20, 12V	235-7404P31
C11	x	x	x	x	x	x	x	25, 75V	235-7404P11
C12	x	x						0.22, 250V	24-2015-17
			x	x	x	x	x	0.1, 250V	24-2015-13
C13	x	x	x	x	x	x	x	0.01, 250V	24-2015-1
C14	x	x	x	x	x	x	x	0.068, 250V	24-2015-11
C15	x	x	x	x	x	x	x	0.068, 250V	24-2015-11
C16	x	x	x	x	x	x	x	0.01, 250V	24-2015-1
C22	x	x	x	x	x	x	x	22, 35V	586058-23
C24	x	x						0.047, 250V	24-2015-9
			x	x	x	x	x	0.01, 250V	24-2015-1
C25	x	x	x	x	x	x	x	0.001, 200V	24-2409-1
C27	x	x	x	x	x	x	x	0.01, 250V	24-2015-1
C30	x							0.01, 250V	24-2015-1
		x						0.015, 250V	24-2015-3
			x					0.0033, 200V	24-2409-4
				x	x		x	0.0022, 200V	24-2409-3
						x		0.001, 200V	24-2409-1
C32	x	x	x	x	x	x	x	4, 25V	235-7404P35
C38	x	x	x	x	x	x	x	100, 25V	235-7404P8
C39	x							0.1, 250V	24-2015-13
		x	x	x	x	x	x	0.22, 250V	24-2015-17
C40	x	x	x	x	x	x	x	1.8, 250V	24-2015-28
C41	x	x	x	x	x	x	x	Not Used	
C43	x	x	x	x	x	x	x	0.001, 200V	24-2409-1
C44	x							Not Used	
		x	x	x	x	x	x	0.0022, 200V	24-2409-3
C45	x	x	x	x	x	x	x	10, 200V	24-2496
C46	x	x	x	x	x	x	x	0.01, 250V	24-2015-1
C47	x	x	x	x	x	x	x	0.1, 250V	24-2015-13
C48	x	x	x	x	x	x	x	0.1, 250V	24-2015-13
C49	x	x	x	x	x	x	x	Not Used	
C51	x	x	x	x	x	x	x	0.04, 250V	24-2015-9
C56	x		x	x		x	x	Not Used	
		x			x			0.0047, 250V	24-2409-5
								Diodes	
CR1	x	x	x	x	x	x	x	S11	587565-1
CR2	x	x	x	x	x	x	x	S11	587565-1
CR3	x	x	x	x	x	x	x	S11	587565-1
CR4	x	x	x	x	x	x	x	S11	587565-1
CR5	x	x	x	x	x	x	x	1N825, Zener, 6.2V	588105-3
CR6	x	x	x	x	x	x	x	RD5637	26-1017
CR7	x	x	x	x	x	x	x	RD5637	26-1017
CR8	x	x	x	x	x	x	x	RD5637	26-1017
CR9	x	x	x	x	x	x	x	Not Used	
CR10	x	x	x	x	x	x	x	RD5637	26-1017
CR11	x	x	x	x	x	x	x	RD5637	26-1017
CR12	x	x	x	x	x	x	x	RD5637	26-1017
CR13	x	x	x	x	x	x	x	RD5637	26-1017
CR19A/B	x	x	x	x	x	x	x	S11	587565-1
CR24	x	x	x	x	x	x	x	S16	587565-4
CR25	x	x	x	x	x	x	x	S11	587565-1
CR26	x	x	x		x			Not Used	
				x		x	x	1N4720	26-1006-2

Table 6-4 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Diodes	
CR29	x	x	x	x	x	x	x	1N750, Zener, 4.7V	26-211
CR30	x	x	x	x	x	x	x	RD5637	26-1017
CR31	x	x	x	x	x	x	x	RD5637	26-1017
CR33	x	x	x	x	x	x	x	RD5637	26-1017
CR34	x	x	x	x	x	x	x	RD5637	26-1017
CR37	x	x	x	x	x	x	x	RD5637	26-1017
CR38	x	x	x	x	x	x	x	1N4747A, Zener, 20V	588102-13
CR39	x	x	x	x	x	x	x	RD5637	26-1017
CR40	x	x	x	x	x	x	x	RD5637	26-1017
CR41	x	x	x	x	x	x	x	1N5226B, Zener, 3.3V	588101-3
CR42	x	x	x	x	x	x	x	RD5637	26-1017
CR43	x	x	x	x	x	x	x	RD5637	26-1017
CR44	x	x	x	x	x	x	x	RD5637	26-1017
CR45	x	x	x	x	x	x	x	C106A21, 100V	26-1105
CR46	x	x	x	x	x	x	x	RD5637	26-1017
CR47	x	x	x	x	x	x	x	1N5226B, Zener, 3.3V	588101-3
CR48	x	x	x	x	x	x	x	RD5637	26-1017
CR51	x	x	x	x	x	x	x	RD5637	26-1017
CR52	x	x	x	x	x	x	x	RD5637	26-1017
CR53	x	x	x	x	x	x	x	RD5637	26-1017
CR54	x	x	x	x	x	x	x	RD5637	26-1017
CR55	x	x	x	x	x	x	x	RD5637	26-1017
CR56	x	x	x	x	x	x	x	RD5637	26-1017
CR58	x	x	x	x	x	x	x	RD5637	26-1017
CR59	x	x	x	x	x			Not Used	
						x	x	RD5637	26-1017
CR60	x	x	x	x	x	x	x	RD5637	26-1017
CR63	x	x	x	x	x	x	x	RD5637	26-1017
CR65	x	x	x	x	x	x	x	SS2996	587306-4
CR66	x	x	x	x	x	x	x	RD5637	26-1017
								Transistors	
Q1	x	x	x	x	x	x	x	RT9338	18-146
Q2	x	x	x	x	x	x	x	CA3046 (IC, Transistor Array)	18-605
Q3	x	x	x	x	x	x	x	CA3046 (IC, Transistor Array)	18-605
Q4	x	x	x	x	x	x	x	2N3638	18-143
Q5	x	x	x	x	x	x	x	Dual SA1448	18-176
Q6	x	x	x	x	x	x	x	2N2907A	386-7249P58
Q7	x	x	x	x	x	x	x	2N3638	18-143
Q8	x	x	x	x	x	x	x	2N3638	18-143
Q9	x	x	x					2N697	18-115
				x	x			2N3019	386-7316P1
						x	x	40321	18-165
Q10	x	x	x	x	x	x	x	CA3053 (IC, Diff. Amp)	18-606
Q11	x	x	x	x	x	x	x	40312	18-142
Q14	x	x	x	x	x	x	x	2N697	18-115
Q15	x	x	x	x	x	x	x	2N3641	18-144
Q16	x	x	x	x	x	x	x	2N1671A	18-097
Q17	x	x	x	x	x	x	x	2N3641	18-144
Q18	x	x	x	x	x	x	x	2N3638	18-143
Q19	x	x	x	x	x	x	x	2N3638	18-143
Q20	x	x	x	x	x	x	x	2N3641	18-144
Q21	x	x	x	x	x	x	x	2N5415	18-216
Q22	x	x	x	x	x	x	x	2N3638	18-143
Q23	x	x						2N3638	18-143
			x	x	x	x	x	62490	587062-1
Q24	x	x						2N3638	18-143
			x	x	x	x	x	62490	587062-1
Q25	x	x	x	x	x	x	x	2N5307	18-214

Table 6-4 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35					DESCRIPTION	SORENSEN PART NUMBER
												Resistors (ohms, 1/2W, ±10% unless noted)	
R1	x	x	x	x	x	x	x					220	280-1145P50
R2	x	x	x	x	x	x	x					390, 1W	280-1180P59
R3	x	x	x	x	x	x	x					10	280-1145P2
R4	x	x	x	x	x	x	x					680	280-1145P68
R5	x	x	x	x	x	x	x					357, 1/4W, 1%	28-1285
R6	x	x	x	x	x	x	x					1K	280-1145P74
R7	x	x	x	x	x	x	x					1K	280-1145P74
R8	x	x	x	x	x	x	x					1.2K	280-1145P77
R9	x	x	x	x	x	x	x					2K, 2W, Variable	29-519
R10	x	x	x	x	x	x	x					47K	280-1145P134
R11	x	x	x	x	x	x	x					1.5K	280-1145P80
R12	x	x	x	x	x	x	x					2.2K	280-1145P86
R13	x	x	x	x	x	x	x					820	280-1145P71
R14	x	x	x	x	x	x	x					3.3K	280-1145P91
R15	x	x	x	x	x	x	x					50, 2W, Variable	29-467
R16	x	x	x	x	x	x	x					47	280-1145P26
R17	x		x		x							5.36K, 1/8W, 1%	28-1413
		x										8.66K, 1/8W, 1%	28-1414
				x								4.32K, 1/8W, 1%	586055-190
					x							3.16K, 1/8W, 1%	28-1416
						x						4.12K, 1/8W, 1%	28-1417
R19	x	x	x	x	x	x	x					330	280-1145P56
R20	x	x	x	x	x	x	x					390	280-1145P59
R21	x	x	x	x	x	x	x					1.78K, 1/2W, 1%	28-1373
R22	x	x	x	x	x	x	x					560, 1W	280-1180P65
R23	x	x	x	x	x	x	x					2.2K	280-1145P86
R24	x	x	x	x	x	x	x					2.2K	280-1145P86
R25	x	x	x	x	x	x	x					2.05K, 1/8W, 1%	586055-89
R26	x	x	x	x	x	x	x					560	280-1145P65
R27	x	x	x	x	x	x	x					3.9K	280-1145P95
R28	x	x	x	x	x	x	x					330, 1W	280-1180P56
R29	x	x	x		x		x					Not Used	
				x								2.49M, 1/2W, 1%	28-1396
					x							2M, 1/2W, 1%	28-1399
R30	x	x	x		x		x					Not Used	
				x		x						1	27-983
R31	x	x	x	x	x	x	x					2.7K	280-1145P89
R32	x	x	x	x	x	x	x					2.7K	280-1145P89
R33	x	x	x	x	x	x	x					6.48K, 1/8W, 1%	586055-113
R34	x	x	x	x	x	x	x					560, 1W	280-1180P65
R35	x	x	x	x	x	x	x					22K	280-1145P122
R36	x	x	x	x	x	x	x					5.6K	280-1145P100
R37	x	x	x	x	x	x	x					220	280-1145P50
R44	x	x	x	x	x	x	x					2.2K	280-1145P86
R45	x	x	x									1.2K	280-1145P77
				x	x	x	x					2.2K	280-1145P86
R46	x	x	x									1.2K	280-1145P77
				x	x	x	x					2.2K, 1W	280-1180P86
R49	x	x										18K	280-1145P119
			x	x	x							33K	280-1145P128
						x	x					47K	280-1145P134
R50	x	x	x	x	x	x	x					2.2K	280-1145P86
R51	x	x	x	x	x	x	x					12K	280-1145P113
R52	x		x									12K	280-1145P113
		x										20K	280-1145P120
				x								9.09K, 1/8W, 1%	586250-120
					x							11.0K, 1/8W, 1%	586250-124
						x						7.5K	280-1145P105

Table 6-4 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Resistors (ohms, 1/2W, ±10% unless noted)	
R52						x		10K	280-1145P110
R54	x	x	x	x	x	x		47	280-1145P26
R58	x	x	x	x	x	x		390	280-1145P59
R59	x							150K	280-1145P152
		x	x	x	x	x		68K	280-1145P140
R60	x	x	x	x	x	x		3.9K	280-1145P95
R61	x	x	x	x	x	x		3.3K	280-1145P91
R62	x	x						470	280-1145P62
			x					680	280-1145P68
				x	x			820	280-1145P71
						x	x	1K	280-1145P74
R63	x	x	x	x	x			1K, 2W, Variable	29-503
						x	x	400, 2W, Variable	29-547
R64	x	x	x	x	x	x	x	6.8K	280-1145P104
R65	x	x						4.7K	280-1145P98
			x					12K	280-1145P113
				x	x			22K	280-1145P122
						x	x	33K	280-1145P128
R66	x	x						5.6K	280-1145P100
			x					10K	280-1145P110
				x	x			18K	280-1145P119
						x	x	27K	280-1145P125
R68	x	x	x	x	x	x	x	3.3K	280-1145P91
R69	x	x	x	x	x	x	x	220	280-1145P50
R70	x	x	x	x	x	x	x	10K	280-1145P110
R71	x	x	x	x	x	x	x	30K, 2W	585109-56
R72	x	x	x	x	x	x	x	820	280-1145P179
R73	x	x	x	x	x	x	x	237, 1/4W, 1%	28-1419
R74	x	x	x	x	x	x	x	4.7K	280-1145P98
R75	x	x	x	x	x	x	x	27K, 2W	585109-55
R76	x	x	x	x	x	x	x	120K	280-1145P149
R78	x	x	x	x	x	x	x	5K, 2W, Variable	29-426
R79	x	x	x	x	x	x	x	2.7K	280-1145P89
R80	x	x	x	x	x	x	x	1.2K	280-1145P77
R81	x	x	x	x	x	x	x	470	280-1145P62
R82	x	x	x	x	x	x	x	4.7K	280-1145P98
R84	x	x	x	x	x	x	x	470	280-1145P62
R86	x	x	x	x	x	x	x	1K	280-1145P74
R87	x	x	x	x	x	x	x	1M, 1/4W, 1%	28-1418
R88	x	x	x	x	x	x	x	3.3M	280-1145P200
R89	x	x						27K	280-1145P125
			x					22K	280-1145P122
				x	x			18K	280-1145P119
						x	x	15K	280-1145P116
R92	x	x						150	280-1145P44
			x	x	x	x	x	100	280-1145P38
R96	x	x	x	x	x	x	x	10K, 1/4W, 1%	28-1325
R99	x	x	x	x	x	x	x	470K	280-1145P170
R102	x	x	x	x	x			Not Used	
						x	x	12K	280-1145P113
TB2	x	x	x	x	x	x	x	Terminal Board	43-180
U1	x	x	x	x	x	x	x	LM741CH	585322-1

Table 6-4 (Cont'd)
Replaceable Parts List
PCB Assembly
SRL Fan Cooled Units

CIRCUIT SYMBOL	SRL Model 10-50	10-100	20-50	40-25	40-50	60-17	60-35	DESCRIPTION	SORENSEN PART NUMBER
								Miscellaneous	
XQ3	x	x	x	x	x	x	x	Socket (IC)	585741-1
XQ4	x	x	x	x	x	x	x	" "	585741-1
	x							Printed-Circuit Board Ass'y	190-4118-2
		x						" " " "	190-4118-3
			x					" " " "	190-4118-6
				x				" " " "	190-4118-9
					x			" " " "	190-4118-10
						x		" " " "	190-4118-13
							x	" " " "	190-4118-14

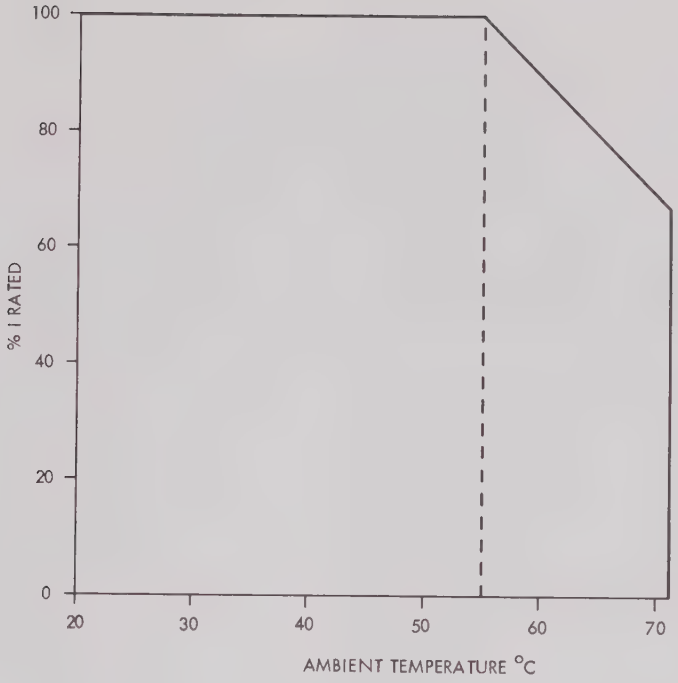


Figure 6-6 SRL Current Derating Characteristics

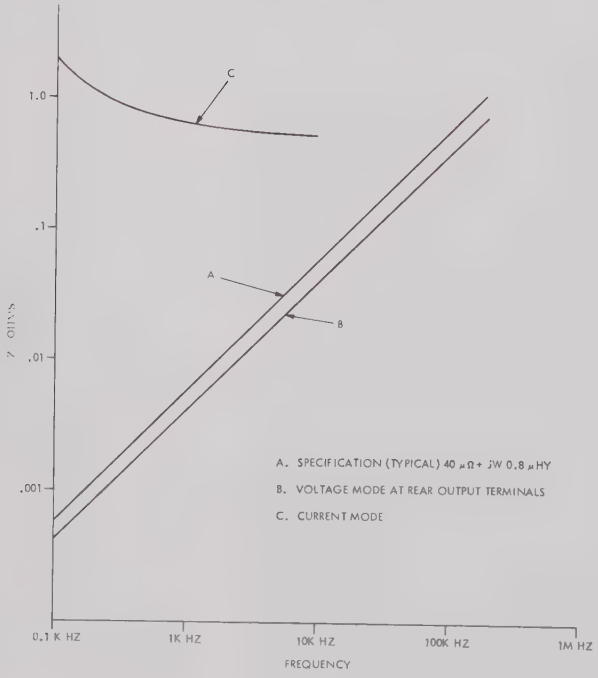


Figure 6-7 SRL Typical Output Impedance Curves

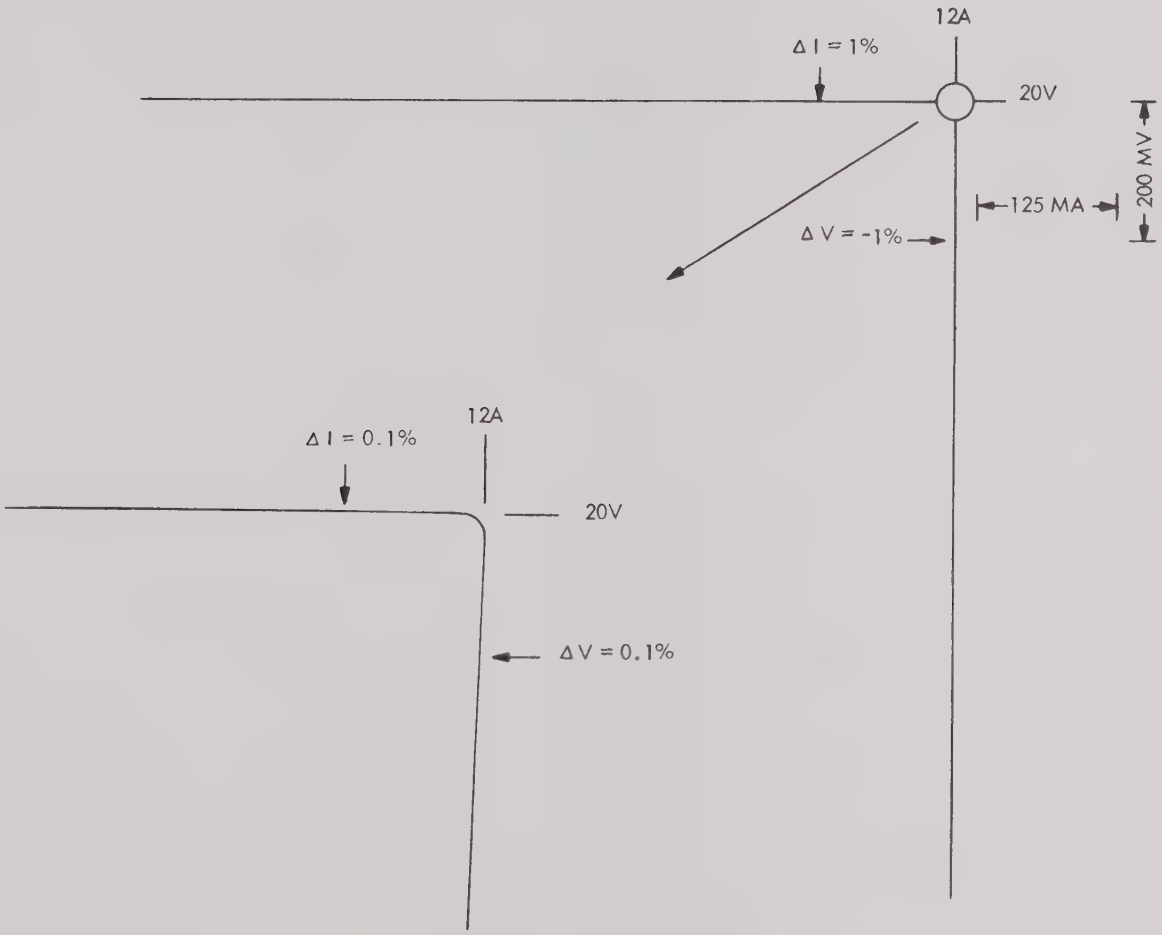


Figure 6-8 Typical Crossover Characteristics (SRL 20-12)

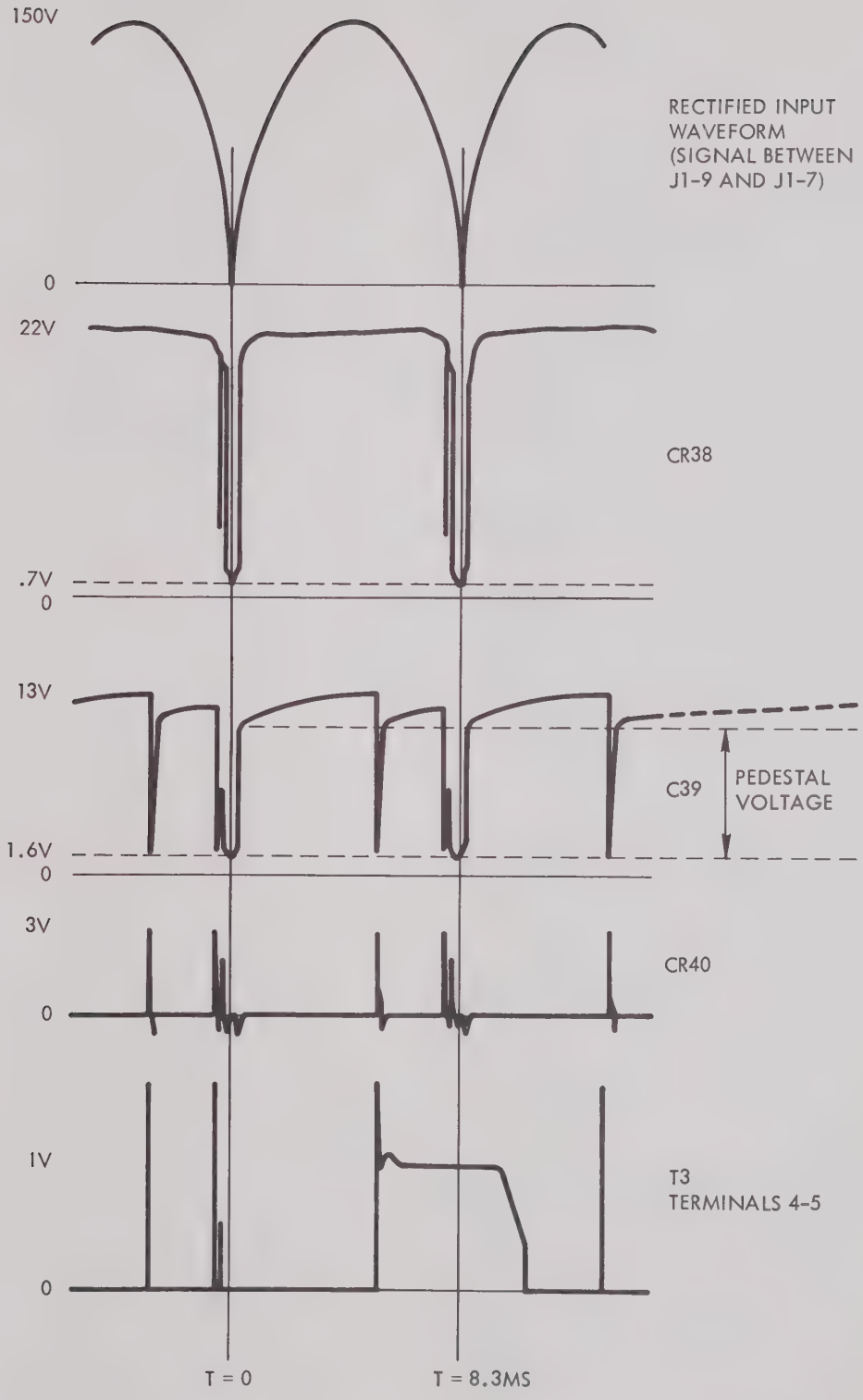


Figure 6-9 Firing Section Waveforms

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